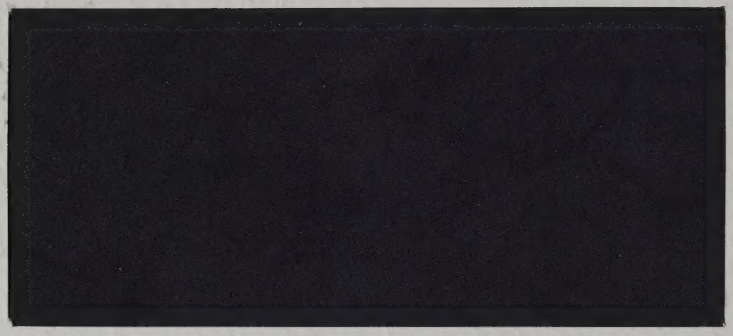
TECHNICAL MANUAL
FOR
ANTENNA COUPLERS

MODELS MC-1002 & MC-1004

mechanical products
div of Narlin Inc

AIKEN ELECTRONICS



TECHNICAL MANUAL
FOR
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TECHNICAL MANUAL

FOR

AIKEN ELECTRONICS ANTENNA COUPLERS

(MODELS MC-1002 & MC-1004)

MC-1002 and MC-1004 Multicouplers use amplifiers covered by U. S. Patent #3,239,770

July 1970

Effectivity: MC-1002, Serial Nos. 106-

MC-1004, Serial Nos. 101-

AIKEN ELECTRONICS
A Division of Aiken Industries
5520 Port Royal Road
Springfield, Virginia 22151

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SECTION 1

GENERAL INFORMATION

1.1 SCOPE

This technical manual covers the description, installation, operation and maintenance for Aiken Electronics Antenna Couplers MC-1002 and MC-1004. The Antenna Couplers are shown in Figures 1.1 and 1.2.

1.2 FUNCTION DESCRIPTION

Antenna Couplers MC-1002 and MC-1004 provide optimum coupling between a single input and as many as eight receivers in a communications type system. As an optimum coupling device, they provide an overall power gain, a high degree of isolation between individual outputs, identical signal amplitude and phase (MC-1002) at all eight outputs, and operate over the wide frequency range of 2.0 MHz to 30 MHz with no tuning required. Other important design considerations include selection of solid state circuits and choice of components to provide a low degree of intermodulation distortion (IM), minimum noise figure, a low input and output voltage standing wave ratio (VSWR), and high reliability.

1.3 QUICK REFERENCE DATA

a. FREQUENCY RANGE: Antenna Couplers MC-1002 and MC-1004 provide a wide frequency range between the values of 2.0 MHz and 30 MHz.

b. INPUT AND OUTPUT CHARACTERISTICS: The Antenna Coupler has a 50 or 75 ohm nominal input and output impedance depending on user specifications. A single coaxial connector located on the rear of the unit provides the antenna input connections. The input VSWR is less than 1.5:1 between 2 MHz and 30 MHz

FIGURE 1-1 ANTENNA COUPLER, FRONT VIEW

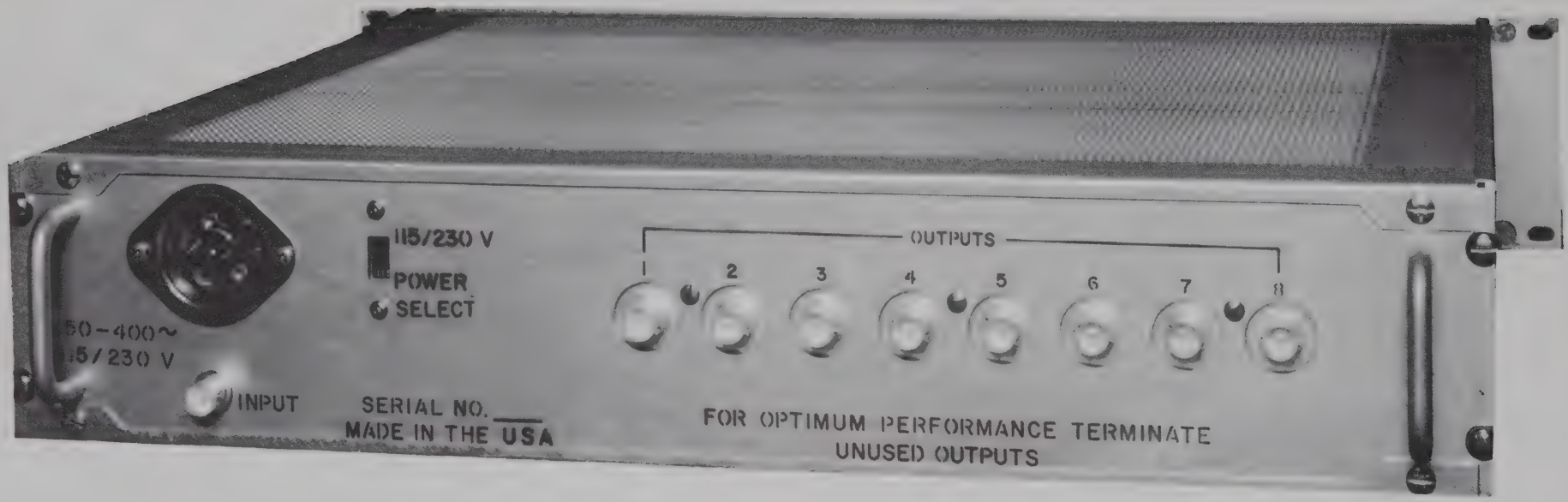


Figure 1-2 ANTENNA COUPLER, REAR VIEW

and is less than 2:1 between 1.5 MHz and 2 MHz. Eight coaxial connections located at the rear of the unit provide for output connections. The output VSWR is less than 1.5:1 between 1.5 MHz and 30 MHz.

c. NUMBER OF OUTPUTS: Eight outputs are normally provided for at the rear of the unit. Additional outputs may be specified by the customer.

d. ISOLATION OF OUTPUTS: Minimum isolation between any two outputs is 40 db between 2 MHz and 30 MHz.

e. INTERMODULATION DISTORTION: Second and third order IM products of two 0.25 volt signals applied to the input are down 80 db referenced to the output from one 0.25 volt input signal over the frequency range of 1.5 MHz to 30 MHz.

f. NOISE FIGURE: The Antenna Coupler has a noise figure of less than 6 db between 1.5 MHz and 30 MHz.

g. GAIN: Gain to each output is 1 to 3 db.

h. GAIN TRACKING: The gain difference between outputs and also between antenna couplers is less than 1 db at any one frequency between 2 MHz and 30 MHz, and less than 1.5 db at any one frequency between 1.5 MHz and 2 MHz.

i. PHASE TRACKING: The phase difference between outputs of a MC-1004 and also between antenna couplers is less than $\pm$ 1 degree at any one frequency between 2 MHz and 30 MHz. Phase is not specified for the MC-1002.

j. POWER SUPPLY CHARACTERISTICS: The Antenna Coupler requires a line voltage source of 120 or 240 volts, $\pm$ 10%, 48 to 63 cps, single phase, and approximately 35 watts. Selection of 120 or 240 volts is made by means of a rear panel switch.

k. AMBIENT TEMPERATURE: The ambient temperature range under operating conditions is 0°C to 50°C. Under storage conditions the temperature limitations are -54°C (-65°F) and 71°C (160°F).

l. INPUT PROTECTION: Antenna Couplers MC-1002 and MC-1004 are protected against damage from lightning and strong CW signals.

1.4 EQUIPMENT LISTS

a. TRANSISTOR COMPLEMENT LIST: The transistor listing is shown in Table 1.1.

b. SPECIAL TOOLS AND MATERIALS REQUIRED: Special tools and materials required in support of Antenna Coupler maintenance operations are listed in Table 1.2.

c. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED: Equipment and publications required for servicing are listed in Table 1.3. Equivalent instruments may be substituted for those listed.

TABLE 1.1 ANTENNA COUPLER MC-1002 AND MC-1004, TRANSISTOR COMPLEMENT

SUBASSEMBLY	TRANSISTOR TYPE	PER ANTENNA COUPLER
Amplifier Subassembly	PT4599 (NPN) or 2N4428	2
Amplifier Subassembly	2N5160 (PNP)	2

TABLE 1.2 ANTENNA COUPLER MC-1002 AND MC-1004, SPECIAL TOOLS REQUIRED

QUANTITY PER EQUIPMENT	NOMENCLATURE			REQUIRED USE
	ITEM	MANUFACTURER	PART NO.	
1	Adjustment Tool	JFD	5284	For adjustment of IM, Isolation, and Phase Tracking

TABLE 1.3 ANTENNA COUPLER MC-1002 AND MC-1004

EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED

ITEM	QUANTITY REQUIRED	NOMENCLATURE		
		DESCRIPTION	MANUFACTURER	PART NO.
1	1	Multimeter (VOM)	Triplett	630-A
2	1	Transistor Tester	Triplett	2590
3	2	RF Signal Generator	Hewlett-Packard	606
4	1	RF VTVM (with 91-3C RF Probe and High Impedance Adapter)	Boonton	91 CA
5	1	75-ohm Adapter (for RF VTVM)	Boonton	91-8B-1
6	1	Sweep Generator	Hewlett-Packard	675-A
7	1	Phase Amplitude Detector	Hewlett-Packard	767-A
8	1	Oscilloscope	Tektronix	535
9	1	Variable Attenuator (75 ohm)	Codeco	B550
10	1	Fixed Attenuator Pad - 10 db	Applied Research Inc.	HFA-50
11	2	Fixed Attenuator Pad - 20 db	Applied Research Inc.	HFA-50
12	3	75-ohm Coaxial Load - Type BNC	Applied Research Inc.	HFT-75
13	3	Matching Pad	Applied Research Inc.	HFAM-(75/50)
14	1	Power Combiner Type 1 1:2 75Ω to 50Ω	Aiken Electronics	PD-1002
15	1	Power Combiner Type 2 1:2 75Ω to 50Ω	Aiken Electronics	PD-1003
16	1	Noise Generator	Aero Space Research	NS-6
17	1	HF Receiver	Empire Devices	NF105
18	As Rq'd	Misc. Coaxial Adapters	Amphenol	31-008
19	As Rq'd	Misc. Coaxial Cables		

SECTION 2

INSTALLATION

2.1 UNPACKING AND HANDLING

Antenna Multicouplers MC-1002 and MC-1004 are packed in a cardboard container at the factory for domestic shipment. The unit should be stored in an upright position, as marked on the box. Normal care should be exercised when handling and unpacking the unit. Do not use a knife or hook to open the carton, as that may damage the unit.

2.2 INSTALLATION LAYOUT

The unit is designed for mounting in a standard 19-inch rack having universal mounting hole spacings for the front panel.

2.3 POWER REQUIREMENTS

The multicoupler requires a line voltage source of 120 or 240 volts ± 10%, 48 to 63 cps, 3-wire single-phase, approximately 35 watts.

2.4 INSTALLATION REQUIREMENTS

a. INSTALLATION POINTERS

(1) Exercise care in handling the multicouplers. The unit can be temporarily balanced on its side but is easily subject to knocking over. Always lay the unit on its bottom surface.

(2) Before installing into rack, perform the internal inspection (with case removed) discussed in paragraph 2.5.

(3) Connect coax cables and power cable to Antenna Coupler after front panel is secured to rack.

(4) Retain packing material in storage for possible future use in reshipping the equipment.

b. OUTLINE DRAWING

For dimensions and clearances important in installation, refer to the outline drawing of Figure 2.1.

c. INTERCONNECTING DIAGRAM

Interconnections of this unit are shown in Figure 2.2. These connections should be made carefully in order to obtain maximum coupling. Unused outputs should be terminated to insure optimum performance.

2.5 INSPECTION AND ADJUSTMENTS

a. VISUAL INSPECTION

Before inspection, make sure the unit is de-energized. Then make the following inspections with the case removed.

(1) Check that all coax cable and wiring harness connections are secure.

(2) Check the printed card connection pins for proper contact.

(3) Check the POWER ON switch and the test point selector switch for damage.

(4) Check all transistors and heat sinks for proper seating.

(5) Make sure the fuse and the indicating lamp are intact and not open.

(6) Inspect for any damaged or loosened component.

(7) Inspect finished surfaces for any sign of damage.

b. POWER SUPPLY ADJUSTMENTS

With the unit energized and warmed up for ten minutes, check the power supply voltage and adjust as required. Use the procedure outlined in paragraph 3.5 b. under Operator's Maintenance.

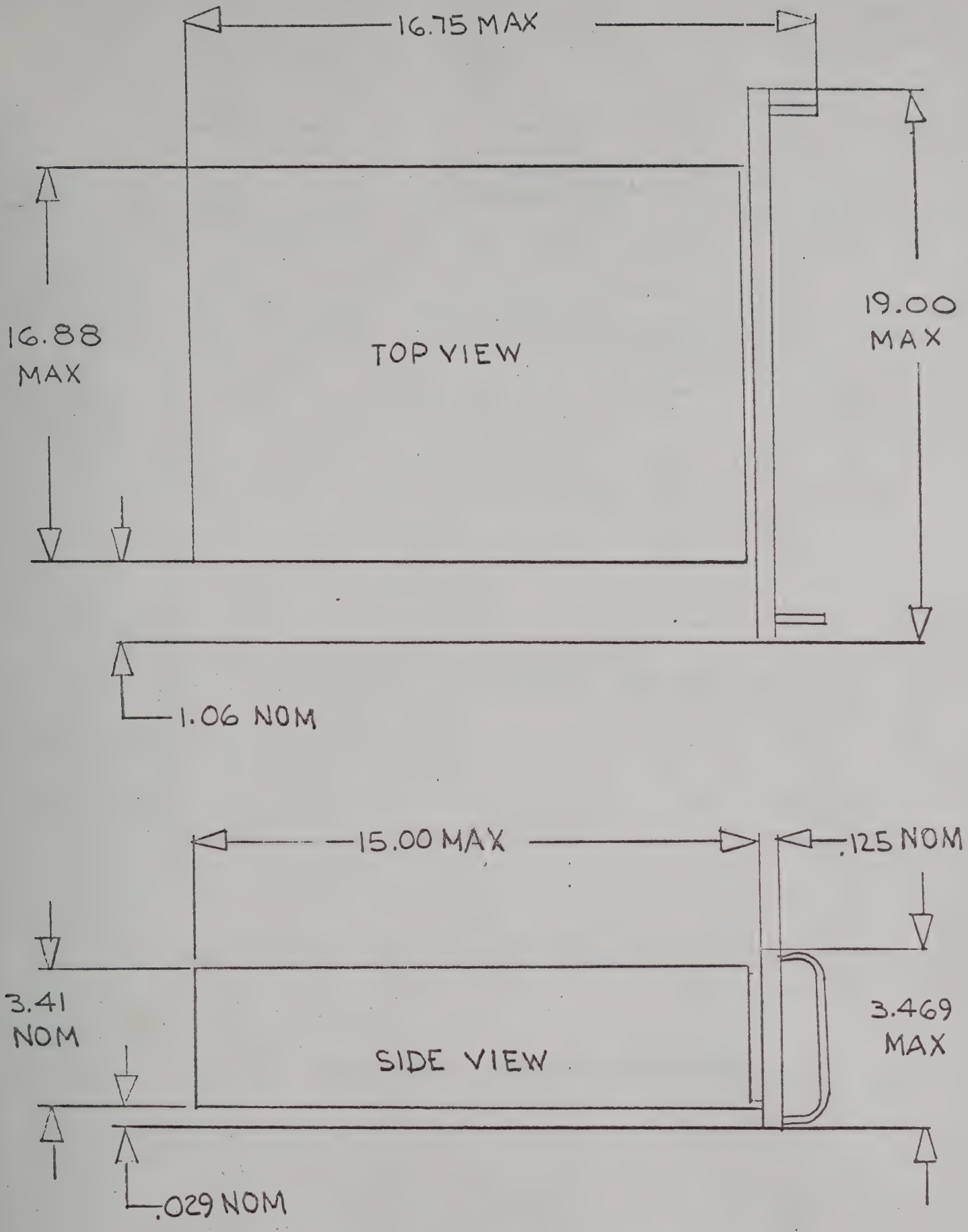
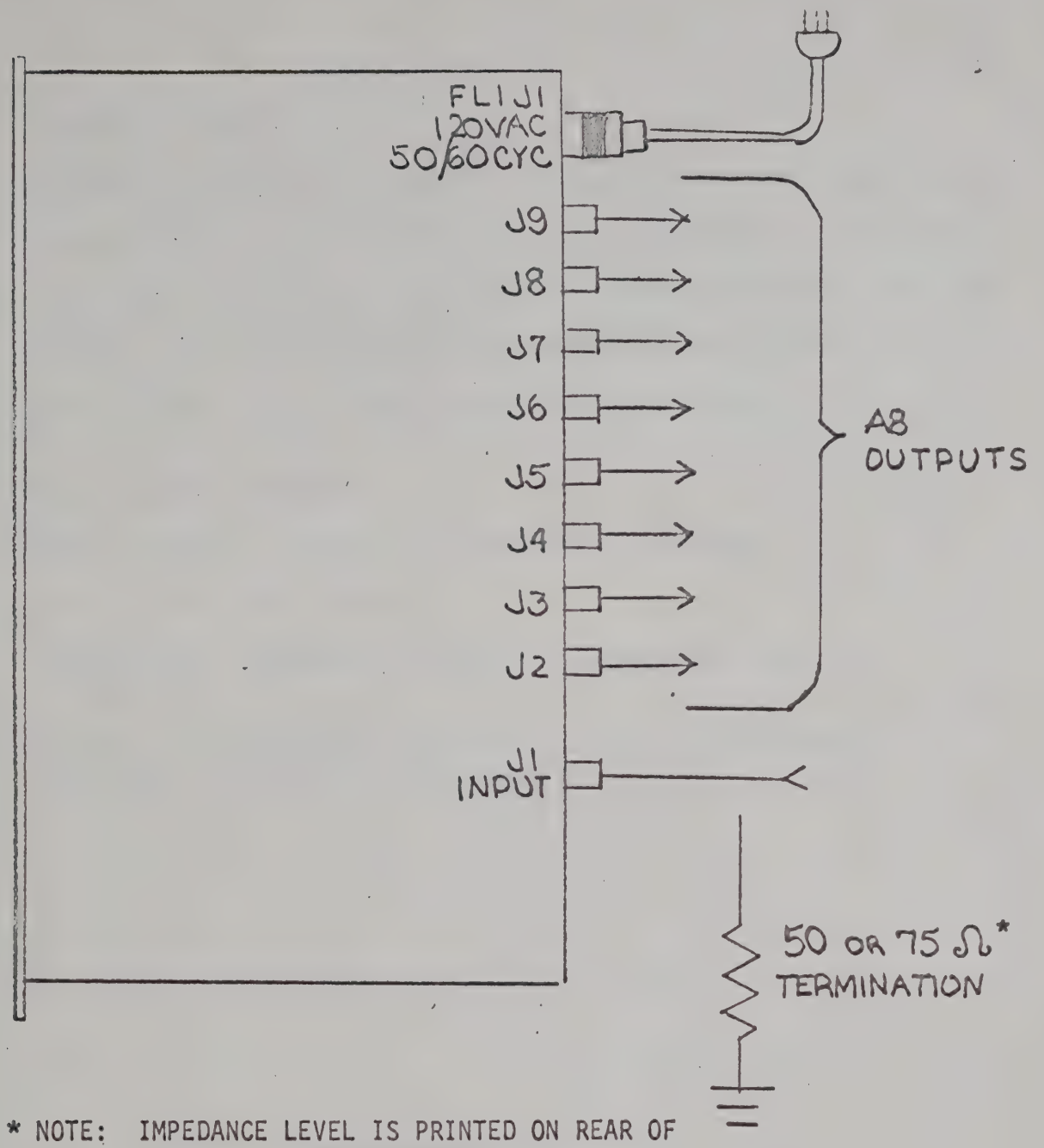


FIGURE 2-1 ANTENNA COUPLER OUTLINE DRAWING



* NOTE: IMPEDANCE LEVEL IS PRINTED ON REAR OF MULTICOUPLER

2-2 ANTENNA COUPLER INTERCONNECTION DIAGRAM

2.6 INTERFERENCE REDUCTION

The Antenna Coupler was designed to minimize interference generation and to be unsusceptible to interference from other equipment. Good practice says that any receiving equipment should be located some distance from high power equipment. The Antenna Coupler is designed to meet interference specifications without the shielding benefits of an enclosure or rack.

2.7 PREPARATION FOR RESHIPMENT

Prepare the Antenna Coupler for reshipment as follows:

a. Turn off the POWER switch.

b. Remove all interconnecting cables. Place dust covers on receptacles.

c. Place unit in container; add packing material to prevent the unit from shifting, and seal the container.

SECTION 3

OPERATOR'S SECTION

3.1 FUNCTIONAL OPERATION

Antenna Couplers MC-1001 and MC-1003 provide optimum coupling between a single antenna and as many as eight receivers. Additional antenna connections may be obtained by connecting Antenna Couplers in cascade or by special models with additional outputs. No operating procedure other than energizing the unit is required. There are no tuning adjustments. Each of the eight receivers may be tuned to any frequency within the pass band (1.5 MHz to 30 MHz) of the Antenna Coupler. If less than eight outputs are used, each unused output may be terminated to insure optimum performance.

3.2 PREPARATION FOR USE

Provided the Antenna Coupler is installed as described in Section 2, no further preparation is required.

3.3 OPERATOR'S DATA

The function of the various controls and indicators located on the Antenna Coupler are tabulated in table 3.1. Locations of the controls and indicators are shown in figure 1.1.

3.4 OPERATING PROCEDURES

a. PREOPERATIONAL CHECKLIST

Perform the following checks before energizing the Antenna Coupler:

(1) Check for the presence of known good fuses, including the spare, on the front panel.

(2) Check that the power switch is in the OFF position.

(3) Check that the AC power cable is connected at the rear to the unit.

TABLE 3.1 ANTENNA COUPLER MC-1002 AND MC-1004, CONTROLS AND INDICATORS

(Refer to Figure 1.1)

CONTROL OR INDICATOR	FUNCTION
ON-OFF Switch	Applies AC line power to unit when placed in ON position.
POWER Lamp	Lights to indicate that power is applied to unit.
1 AMP FUSE	Fuses one side of AC input line.

b. STARTING PROCEDURE

Normal operation requires only that the unit be energized by placing the ON-OFF switch in the ON position. The POWER ON lamp should illuminate. Allow the unit to warm up for 10 minutes before making measurements or performing maintenance.

SECTION 4

PRINCIPLES OF OPERATION

4.1 OVERALL FUNCTIONAL DESCRIPTION

Antenna Couplers MC-1002 and MC-1004 provide optimum coupling between a single antenna and as many as 8 recievers in communications systems. A functional block diagram of the unit is shown in Figure 4.1. The basic design approach is that of a transistorized amplifier followed by a passive Power Divider. An RF signal from the antenna is fed to Input 1 of the Antenna Coupler. This signal passes through the high level protector circuit and in turn is fed to an amplifier subassembly where it is amplified approximately 13 db. The output of the amplifier subassembly drives a passive Power Divider which provides 8 identical output signals at J2 through J9.

A schematic diagram of the Antenna Coupler showing interconnections of all modules is shown in Figure 4.2.

Top and bottom views of the Antenna Coupler showing subassembly locations are shown in Figures 4.3 and 4.4.

4.2 AMPLIFIER SUBASSEMBLY (FIGURE 4.5)

A schematic diagram of the Amplifier Subassembly is shown in Figure 4.5. The circuit consists of two complementary pairs of transistors (Q1, Q3,) and Q2, Q4) operating in push-pull. Each complementary pair consists of a common emitter transistor (Q1 and Q3) with emitter (current) degeneration and a common collector transistor (Q2 and Q4) in cascade.

A simplified schematic of the complementary pair configuration is shown in Figure 4.6. A voltage feedback loop from the collector of the second stage to the emitter of the first stage across resistor R_E serves to raise the input impedance of transistor Q1 to a very high value. The feedback input and output impedances to the desired values. Relationships between R_E, R_F, and R_L also determine the gain of the circuit.

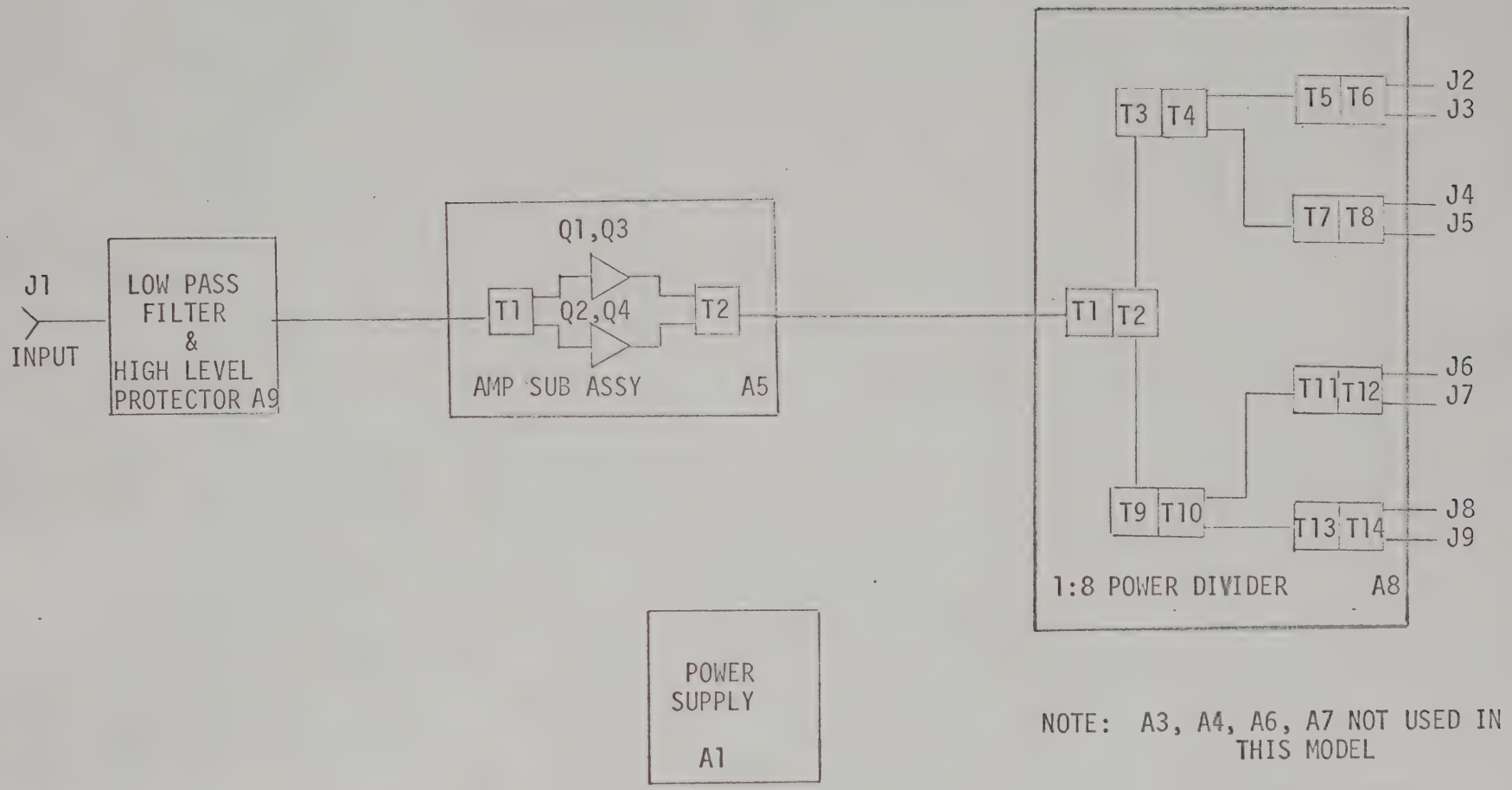


FIGURE 4-1 ANTENNA COUPLER FUNCTIONAL BLOCK DIAGRAM

AIKEN ELECTRONICS DRAWING 34-0079

(SEE POCKET IN BACK OF THIS MANUAL)

FIGURE 4-2 SCHEMATIC DIAGRAM OF ANTENNA COUPLER

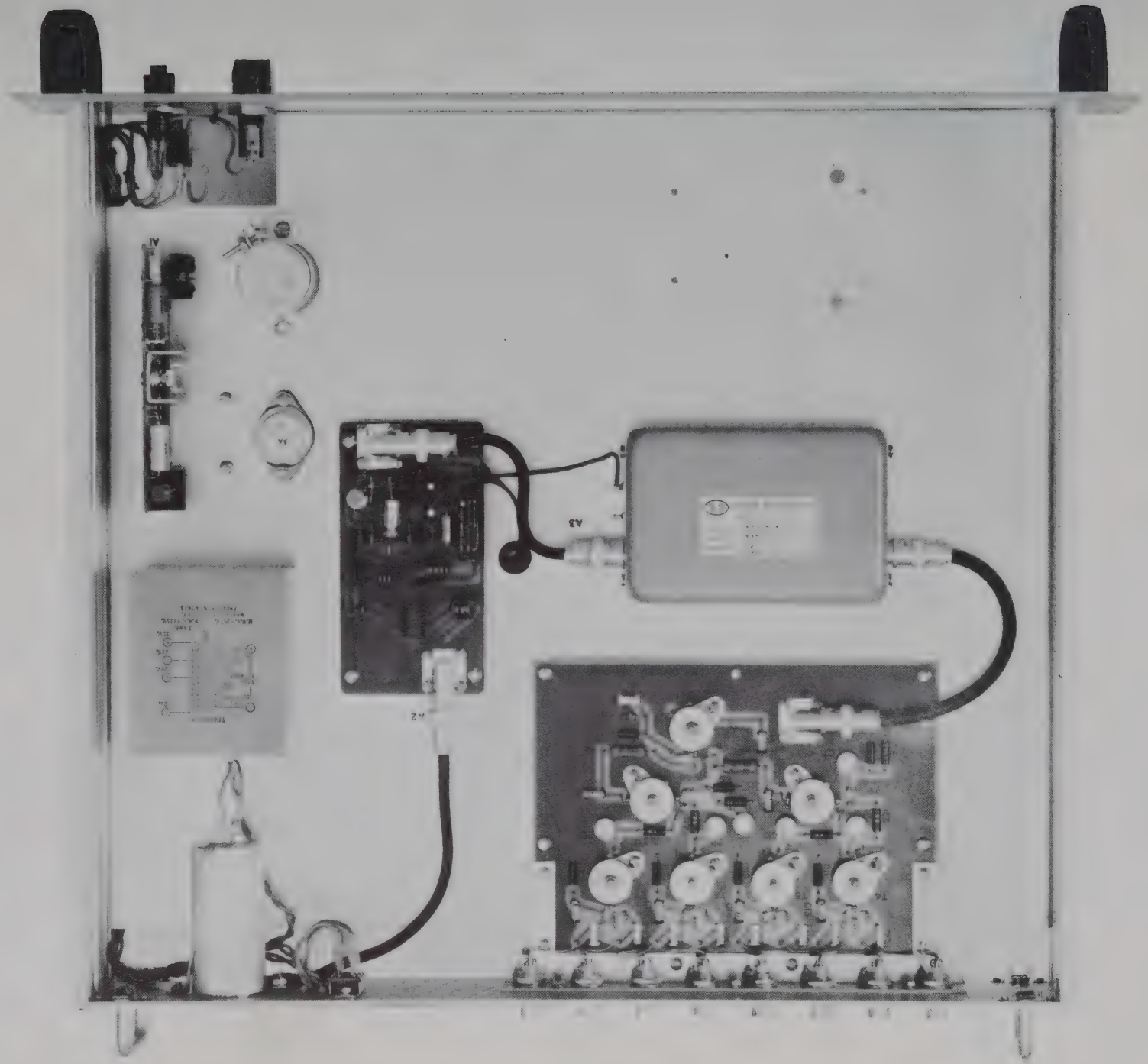


FIGURE 4-3 ANTENNA MULTICOUPLER, TOP VIEW

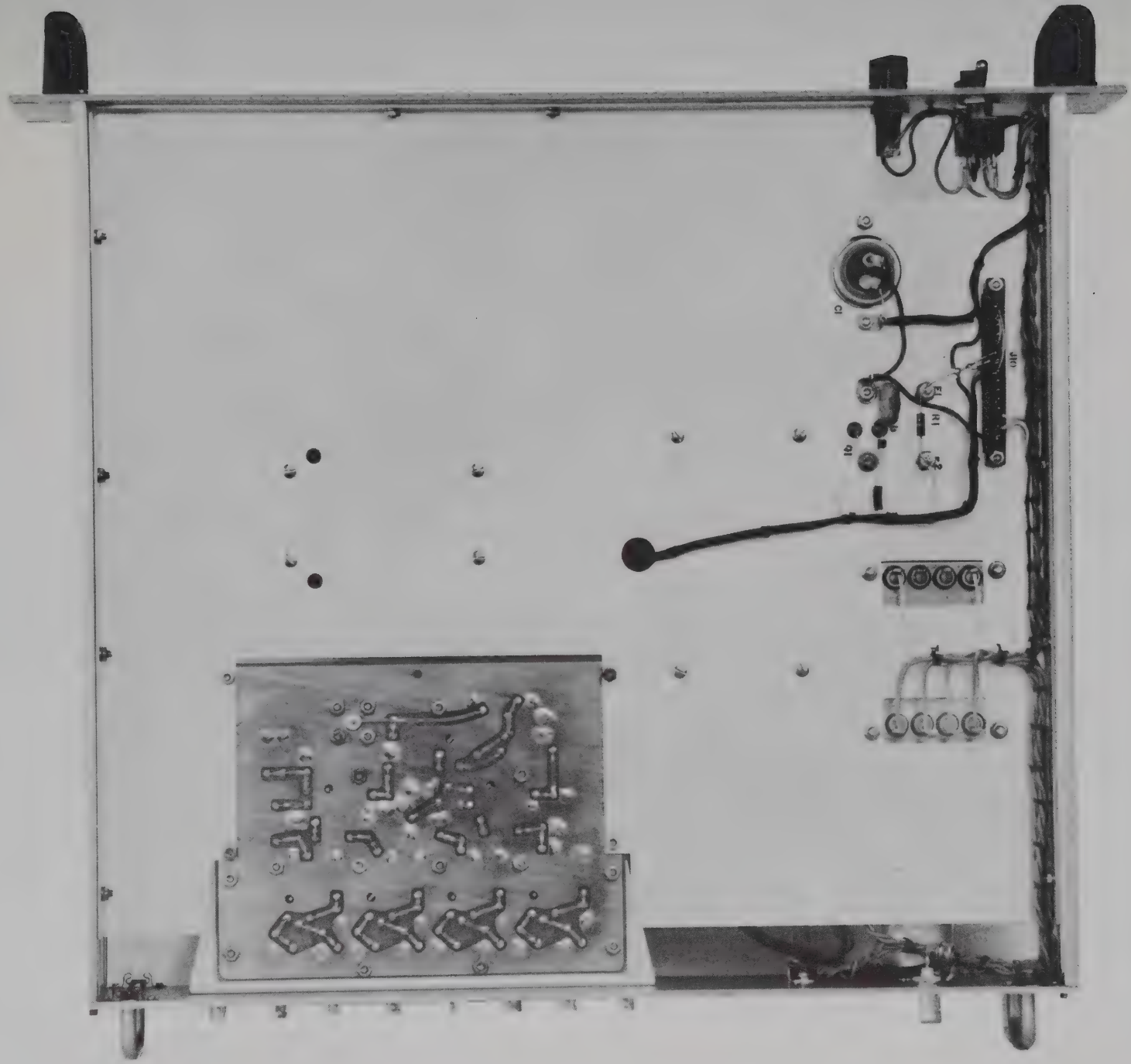
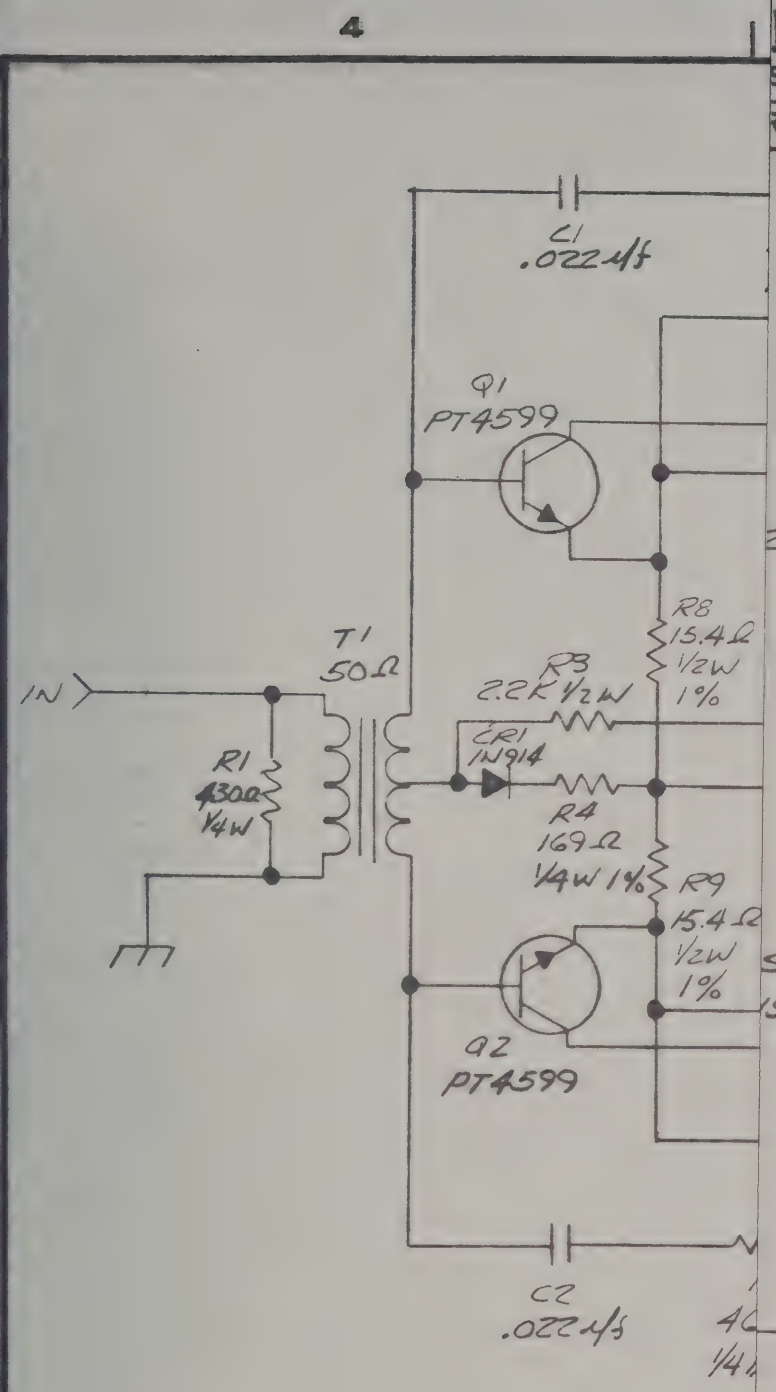


FIGURE 4-4 MULTICOUPLER, BOTTOM VIEW



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SPECIFICATION OR MATERIAL	REF DESIG

P/G	USE
APP	
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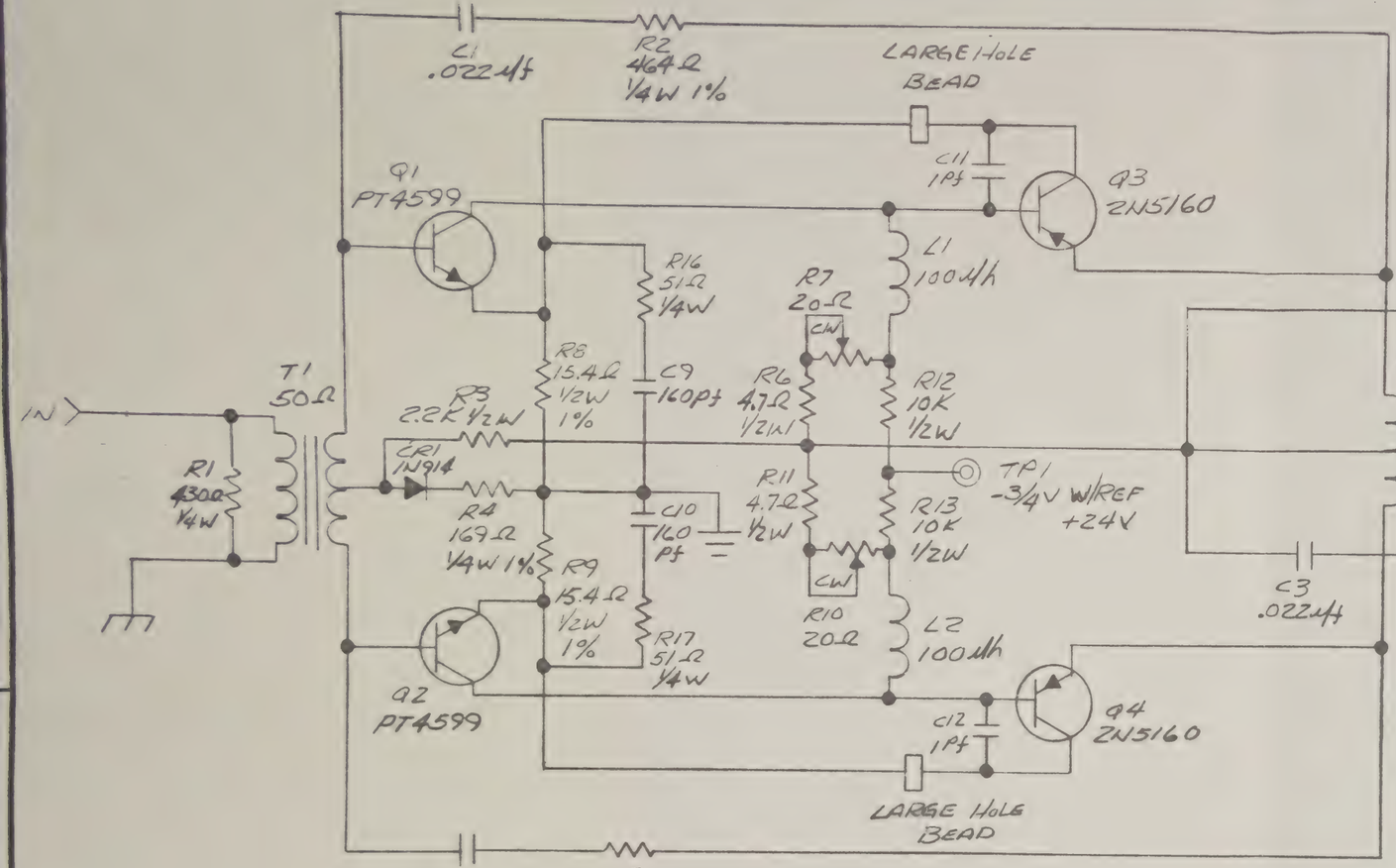
AIKEN ELECTRONICS
ALEXANDRIA, VIRGINIA

SCHEMATIC
AMPLIFIER
A1003-4

SIZE	
B	17-0076

SHEET 4-6

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD



NOTE:
1. UNLESS OTHERWISE SPECIFIED RESISTORS ARE ±5%

50/75Ω 12.5 db GAIN

QTY REQD	QTY REQD	SYM	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
—2	—1				LIST OF MATERIALS			

P/G	USED ON	NEXT ASSY
APPLICATION		
FINISH:		

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES.
TOLERANCES ON:
FRACTIONS DECIMALS ANGLES
± ± ±

MATERIAL:

SIGNATURE	DATE
DR R SCELSI	4/6/71
DWG SUP	
CHK	
DES ENGR	
ENGR	
ENGR	
PROJ	
APPD	

AIKEN ELECTRONICS
ALEXANDRIA, VIRGINIA

SCHEMATIC
AMPLIFIER
A1003-4

CODE IDENT NO.	SIZE	
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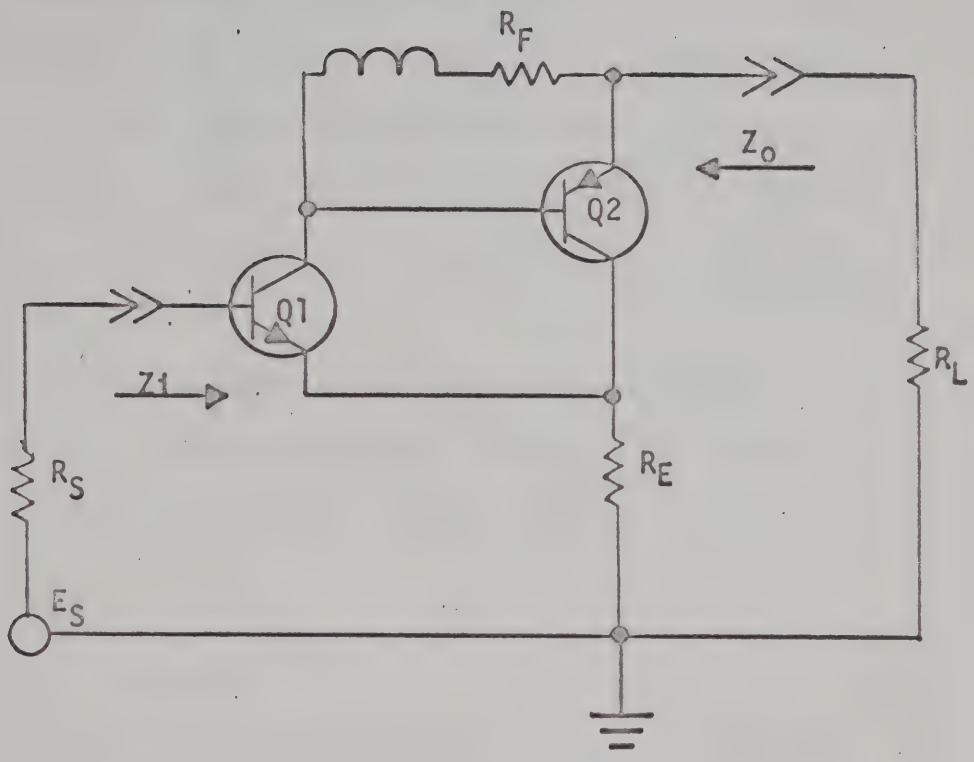


FIGURE 4-6. COMPLEMENTARY TRANSISTOR PAIR, SIMPLIFIED SCHEMATIC DIAGRAM

The push-pull arrangement of the two complementary pairs provides for improved second order intermodulation product rejection. Extensive use of negative feedback tends to minimize the effects of variations in transistor parameters making it less difficult to meet the stringent phase and gain tracking requirements. In addition, negative feedback increases the bandwidth of the amplifier and improves its linearity, thus optimizing its third order IM distortion characteristics.

Since broadband circuitry is employed in the Amplifier Subassembly, there are no tuning adjustments. Means are provided, however, to optimize intermodulation distortion performance. Potentiometers R_6, and R_{11} serve this purpose.

4.3 MC-1004 1:8 POWER DIVIDER (FIGURES 4.7 & 4.8)

Schematic diagrams of the MC-1004 phase tracking 1:8 Power Divider are shown in Figures 4.7 and 4.8. The circuit consists of a binary arrangement of wide band transformer hybrids. A simplified schematic of a transformer hybrid is shown in Figure 4.10. The basic theory of operation is as follows: If a signal voltage is applied across the center top of the secondary winding, port 4, two voltages equal in amplitude and phase and 3 db lower than the input signal, will appear across ports 3 and 5. If the device is properly terminated at all ports, no signal power will be dissipated in the primary winding termination resistor (R_a) across port 2. If a signal is applied to port 3, the signal divides equally between R_a and R_c, and only an infinitesimal amount of signal appears at port 5. When ports 3 and 5 are used as output ports, then the ratio of the power applied to one output port to the power appearing at the opposite output port is defined as the hybrid isolation. The isolation performance is dependent upon terminating impedances at ports 2 and 4, and

AIKEN ELECTRONICS DRAWING 44-0007

(THIS DRAWING SUPPLIED WITH MODEL MC-1004, ONLY)

FIGURE 4-7 MC-1004, 1:8 POWER DIVIDER, 50Ω

AIKEN ELECTRONICS DRAWING 44-0006

(THIS DRAWING SUPPLIED WITH MODEL MC-1004, ONLY)

FIGURE 4-8 MC-1004, POWER DIVIDER, 75Ω

is greater than 40 db when these impedances are correct.

In the 1:8 Divider circuit port 4 is fed from a 75:37:5 ohm autotransformer. The autotransformer together with the hybrid transformer forms a hybrid module with 75 ohm input and output impedances. This module is cascaded in three series junctions to provide eight output signals identical in amplitude and of the same phase polarity.

In the circuit of Figure 4.9 the various fixed value capacitors employed are used for matching purposes to achieve broad band operation. Capacitors C10, C13, C14, C17, C21, C24, C25, and C28, which parallel the outputs of the divider, are variable, and are used to fine adjust the phase of each output port. This adjustment permits several degrees of phase control at 30 MHz and thus makes it possible to phase track the eight outputs of the Antenna Coupler with each other as well as with any output of any other Antenna Coupler.

Capacitor C29, also may be varied, and is used as an adjustment to optimize the output to output isolation of the 1:8 Divider. This variable capacitor compensates for minor impedance variations presented to the 1:8 Divider by the 4:1 Combiner.

4.4 MC-1002 1:8 POWER DIVIDER

Model MC-1002 does not provide full phase tracking at the outputs and uses a simpler power divider then described in paragraph 4.3 above. The schematics of the MC-1002 power divider are shown in Figures 4.10 & 4.11. This power divider is constructed of the same hybrids described earlier, however, because of the deletion of phase tracking requirements the autotransformers present in the MC-1004 power divider are deleted. Operation is the same as described above and output to output isolation performance is equivalent to that for the phase tracking power divider.

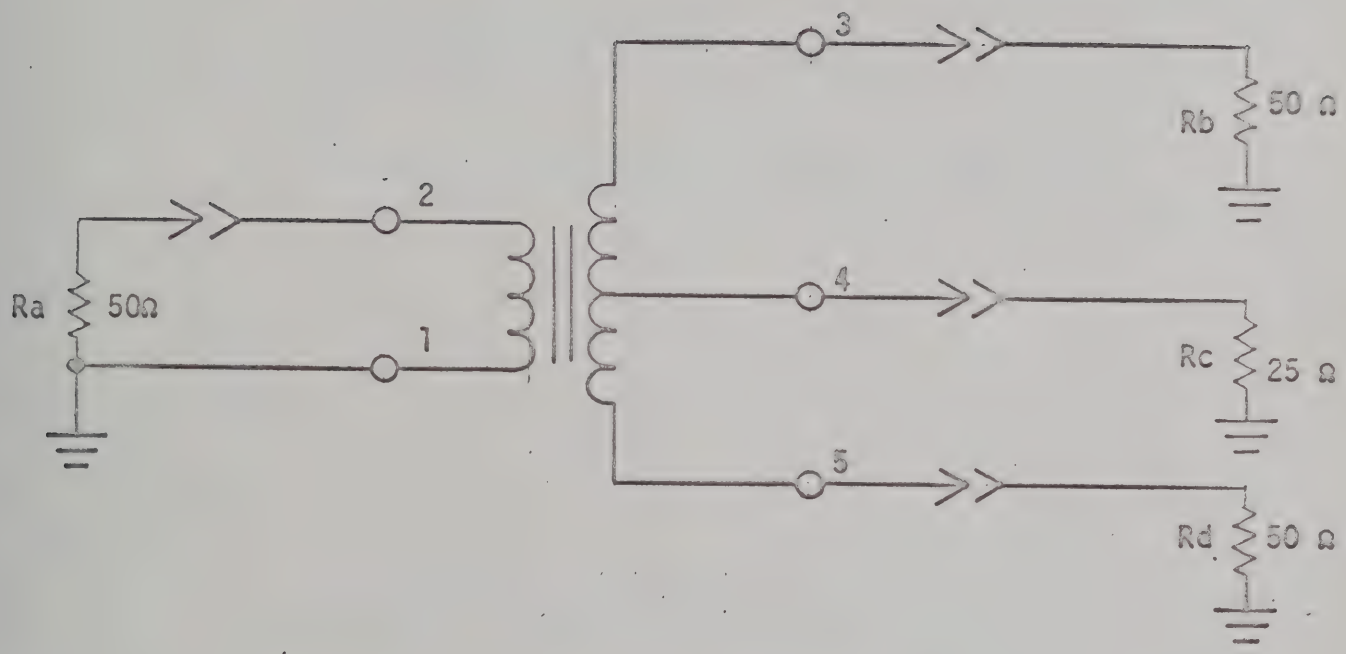


FIGURE 4-9. TRANSFORMER HYBRID SIMPLIFIED SCHEMATIC DIAGRAM

AIKEN ELECTRONICS DRAWING 34-0059

(THIS DRAWING SUPPLIED WITH MODEL MC-1002, ONLY)

(SEE POCKET IN BACK OF THIS MANUAL)

FIGURE 4-10 MC-1002, 1:8 POWER DIVIDER, 50Ω

AIKEN ELECTRONICS DRAWING 34-0013

(THIS DRAWING SUPPLIED WITH MODEL MC-1002, ONLY)

(SEE POCKET IN BACK OF THIS MANUAL)

FIGURE 4-11 MC-1002, 1:8 POWER DIVIDER, 75Ω

4.5 POWER SUPPLY

The power supply is a modular unit. It requires a single-phase input of 120 or 240 ± 10% volts, 48 to 63 cps and provides a 24.0 volts DC output. The VOLTAGE ADJUST potentiometer allows adjustment in the 24.0 VDC level. The potentiometer is located on the regulator module.

The power supply is designed to withstand a prolonged short circuit on the output. In addition, it features line plus load regulation of ± 0.2%, ripple less than 10 millivolts peak to peak, and an output voltage adjustment range of 6% total.

4.6 FILTER ASSEMBLY

To prevent RF interference from entering the Antenna Coupler from the input power lines an RF Filter Assembly (FL1) has been incorporated. To discharge the relatively large capacitors in the filter, external bleeder resistors are connected from each output line to ground.

4.7 INTERCONNECTIONS

All DC power and test point connections to the Amplifier Subassemblies are hard wired. All RF connections are made through coaxial cables.

4.8 INPUT RF FILTER AND HIGH LEVEL PROTECTION

MC-1002 and MC-1004 multicouplers are fully protected from undesired signals. A gas discharge diode is mounted directly across the antenna terminals to protect against high voltages such as lightning. Subassembly A9 provides protection from high frequency out of band signals by means of a low pass filter and from CW inband signals by means of a special relay circuit.

The relay circuit disconnects the input circuit in the presence of high level inband signals. It operates by sensing the presence of current limiting in the power supply to determine that high level signals are present. A schematic of the low pass filter and relay protection circuit is shown in Figure 4-1 2. When strong CW signals are present this circuit will remove all inputs while periodically sampling the input for a few milliseconds to determine if the strong signal is still present. Upon removal of the strong signal the circuit reconnects inputs to the amplifier for normal operation. The front panel pilot light flashes during the presence of strong signals as an indication that operation is interrupted by the protection circuit.

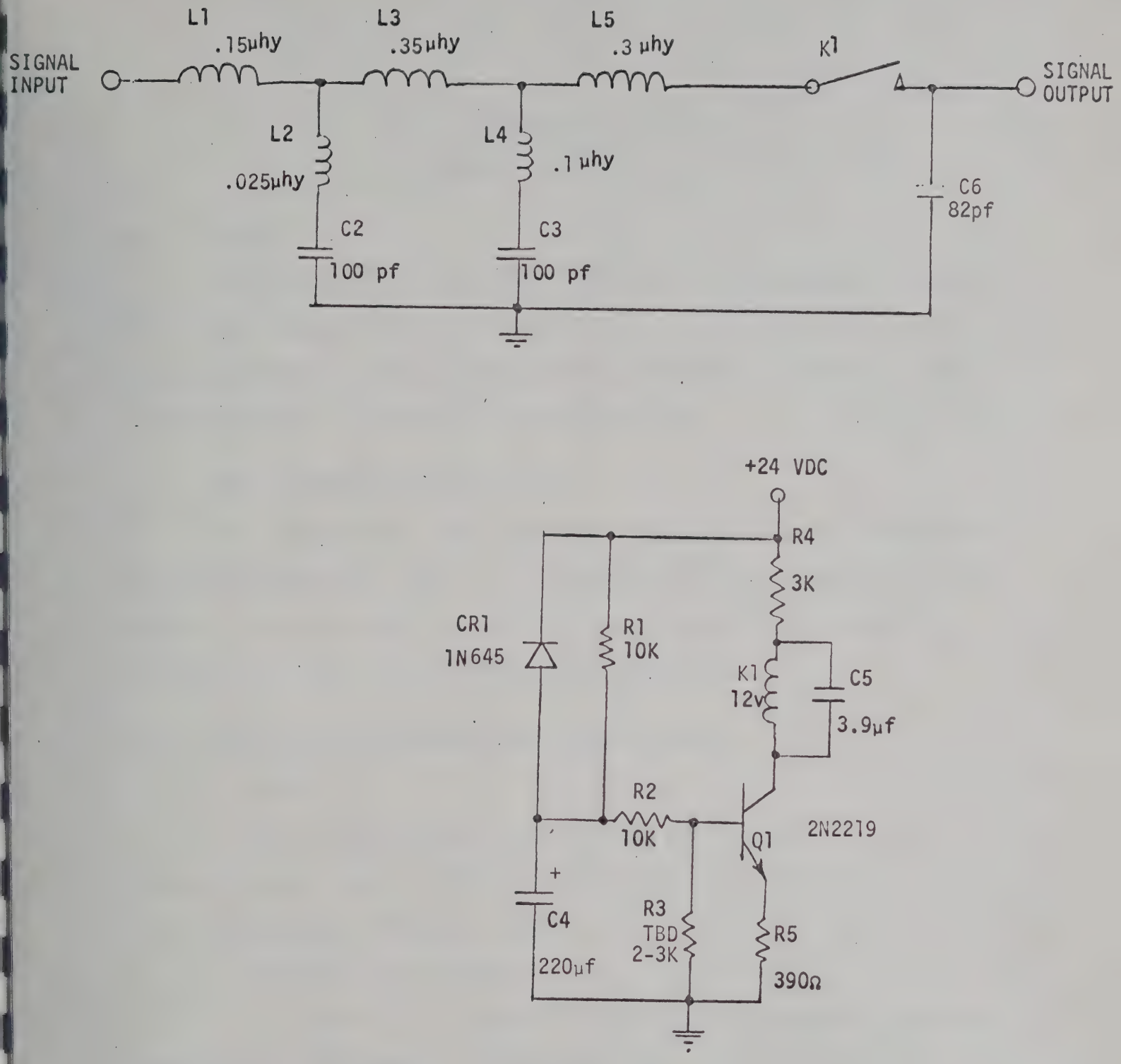


Figure 4-12 INPUT LOW PASS FILTER & HIGH SIGNAL LEVEL PROTECTION CIRCUIT

SECTION 5

TROUBLE-SHOOTING

5.1 GENERAL

This section covers preventive and corrective maintenance. Preventive maintenance coverage begins with visual inspection and goes on to detail routines designed to prevent the occurence of failures. Corrective maintenance coverage is confined to trouble-shooting.

5.2 TEST EQUIPMENT AND SPECIAL TOOLS

Test equipment and tools required in the maintenance of the Antenna Coupler are listed in Table 1.5. In addition to this equipment, it will be helpful if one subassembly of each type used in the Antenna Coupler is available as a test standard during trouble-shooting.

5.3 PLAN FOR TROUBLE-SHOOTING THE ANTENNA COUPLER

a. General

The following subparagraphs provide specific guidelines for implementing the logical trouble-shooting philosophy in the form of checklists covering each of the six steps.

b. Recognizing the Symptoms

(1) Obtain a full report of complaints from operating personnel. Transform and record data as trouble symptoms.

c. Elaborating on the Symptoms

(1) From the information obtained in b. determine if the malfunction is primarily an RF signal problem or a DC malfunction.

(2) Remove the case and perform a careful visual inspection of all internal connections and components.

(3) If it is a DC malfunction, carefully check the amplifier and power supply subassemblies.

(4) If it is an RF malfunction, connect the Antenna Coupler to a RF signal generator and perform operational tests on the unit until all electrical parameters that are out of tolerance are known.

d. Listing the Probable Faulty Functions

(1) For the DC malfunction case, recheck to ascertain the failure is still present. If so, replace or repair the defective subassembly, and test to confirm performance.

(2) For the RF malfunction case, review the overall functional diagram of Figure 4.1 and review the Principles of Operation covered in Section 4.

(3) Apply knowledge of theory against the symptoms observed in order to arrive at a set of educated guesses regarding the most probable causes of trouble. The educated guesses should be aimed at narrowing down trouble to at least the subassembly level.

e. Localizing the Faulty Circuit

(1) After the malfunction has been isolated to a defective assembly, that assembly must be investigated. Review the applicable functional theory in Section 4. Then using the schematic diagram of the subassembly, plus supplementary data from paragraph 5.5, continue narrowing down the probable cause of trouble.

(2) Transistors, which are an easily removed component, may be checked on a transistor checker for DC characteristics (Beta).

f. Analyzing the Cause of Failure

(1) Check voltages at key points in the suspected stage until trouble is isolated to a detail part.

(2) With power off, verify through ohmmeter measurements that the suspected detail part is the actual cause of trouble.

(3) Replace the faulty part and substantiate the fact that it was the actual cause of trouble by performing an operational check on the Antenna Coupler. Proper unit operation signifies that the trouble-shooting operation has been successful.

TABLE 5.1 ANTENNA COUPLER TROUBLE-SHOOTING CHART

ITEM	SYMPTOM	ANALYSIS	NEXT STEP IN LOCALIZING TROUBLE
1	Red POWER ON indicator light does not illuminate.	Light is burned out or input power circuit is open.	Check that lamp bulb has continuity. If satisfactory, check power input cable to unit, and presence of prime power.
2	VDC1 test point voltage is out of limits,(VDC1 is DC voltage across filter capacitor C1).	Failure in power supply rectification and filter circuitry.	Test each power supply component to locate cause of malfunction on regulator module.
3	VDC2 and VDC3 test point voltages are out of limits. VDC2 is base of Q1 VDC3 is emitter of Q1.	One or more of the following: a. Needs adjustment. b. Pass Transistor Q1 may be open.	a. Adjust VDC3 voltages to 24.0v as described in para. 3.5. b. Replace Q1 if VDC2 is within limits and VDC3 is incorrect.
4	Test point voltage on A3 is out of limits. The A3 test point is measured between +24 (Q1 emitter) and R12 (10KΩ) of A5 (end of R12 towards end of board).	Transistor failure.	Replace the transistors one at a time until the test voltage is within 0.75 ± 0.20 volts. Realign for IM performance per Section 6.

TABLE 5.1 ANTENNA COUPLER TROUBLE-SHOOTING CHART (CONTINUED)

ITEM	SYMPTOM	ANALYSIS	NEXT STEP IN LOCALIZING TROUBLE
5	Lack of 120 VAC at power transformer.	Blown fuse due to very large prime power transient, or power supply failure	Replace fuse. If fuse blows again examine AC wiring from fuse holder to power supply for short circuits. If still unsatisfactory, replace power supply.
6	No signal continuity from input to any of the eight outputs.	One or more of the following: a. DC power of Amplifier Subassembly b. Malfunction in protection circuit.	a. Measure presence of DC voltages at Amplifier Subassembly by performing steps 25-32 of Table 5.3. b. Check CR1, Q1, RL1 and replace any faulty items.
7	Low gain at all outputs	One or more of the following: a. Transistor failure b. Component failure on Amplifier Subassembly other than transistors	a. Same as NEXT STEP of item 4. b. Measure gain of Amplifier Subassembly as described in para. 6.4c. Gain limits are shown in Table 5.5. If a low gain amplifier is located, isolate the defective component by performing voltage tests outlined in Table 5.3.

TABLE 5.1 ANTENNA COUPLER TROUBLE-SHOOTING CHART (CONTINUED)

ITEM	SYMPTOM	ANALYSIS	NEXT STEP IN LOCALIZING TROUBLE
7 (Cont.)		c. Excessive insertion loss in 1:8 Divider.	c. Substitute known good 1:8 PD into unit, or isolate the defective component in the malfunctioned 1:8 PD by performing voltage tests outlined in Tables 5.2 and 5.3.
8	Out of tolerance gain tracking between outputs.	Malfunctioned 1:8 PD	Same as NEXT STEP of Item 7d.
9	Out of tolerance phase characteristic. (MC-1004 only.	One or more of the following: a. Malfunctioned Amplifier Subassembly b. Malfunctioned 1:8 PD	a. Substitude a known good Amplifier Subassembly into the unit to isolate the defective module. Isolate the defective component by performing voltage and resistance tests outlined in Tables 5.2, 5.3, and 5.4, b. Same as NEXT STEP of Item 7d.
10	Out of tolerance phase tracking	One or more of the following: a. Individual output phase adjustments not aligned.	a. Remove 1:8 Divider from unit. Measure and adjust phase tracking between outputs as described in para. 4.6c. Minor readjustment

TABLE 5.1 ANTENNA COUPLER TROUBLE-SHOOTING CHART (CONTINUED)

ITEM	SYMPTOM	ANALYSIS	NEXT STEP IN LOCALIZING TROUBLE
10 (Cont)			may be necessary after installation in unit. Measure phase tracking of Antenna Coupler as described in para. 6.4n.
		b. Component failure in 1:8 Div.	b. Same as NEXT STEP of Item 7d.
11	High Input VSWR	One or more of the following: a. Defective interconnecting cables. b. Malfunctioned Amplifier Subassembly	a. Perform RF voltage tests of steps 2.12 of Table 5.2. b. Same as NEXT STEP of Item 9a except measure VSWR as described in para. 6.4c.
12	High Output VSWR	One or more of the following: a. Malfunctioned 1:8 Divider. b. Malfunctioned Amplifier Subassembly	a. Same as NEXT STEP of Item 7d. b. Same as NEXT STEP of Item 12c.

TABLE 5.1 ANTENNA COUPLER TROUBLE-SHOOTING CHART (CONTINUED)

ITEM	SYMPTOM	ANALYSIS	NEXT STEP IN LOCALIZING TROUBLE
13	Poor IM distortion Characteristic	Malfunctioned Amplifier Subassembly.	Measure IM on each Amplifier Subassembly. Adjust for optimum performance as described in para. 6.4c. Replace transistors, if required, and readjust. If still unsatisfactory, perform voltage tests of Table 5.3
14	Low output to output isolation	Malfunctioned 1:8 Divider.	Substitute a known good 1:8 Divider into the unit or isolate the defective component on the malfunctioned 1:8 Divider by performing the voltage tests outlined in Tables 5.2, and 5.3. If required, adjust for best overall isolation as described in para. 6.4c. With unsatisfactory isolation between any two outputs, trouble-shoot the hybrid transformer, and its terminating impedances, common to those two outputs.

TABLE 5.2 RADIO FREQUENCY VOLTAGE CHART

STEP	DEVICE UNDER TEST	INPUT SIGNAL CONDITIONS	RF VOLTMETER MEASUREMENT (See Note 2)		
			LOCATION		TYPICAL INDICATION (See Note 3)
			DESCRIPTION	REF. DESIG.	
1	Antenna Coupler (See Note 4)	(See Note 5)	Amplifier Input	A5T1 pin 2	150 mv
2			Amplifier Output	A5T2 pin 2	680 mv
3			1:8 PD Input	A8J1	680 mv
4			1:8 PD Outputs(8) (See Note 6)	A8J2-A8J9	230 mv
5	Amplifier Subassembly	(See Note 9&10)	Input Transformer	T1 pin 2	200 mv
6			Input Transformer	T1 pin 9	142 mv
7			Input Transformer	T1 pin 5	142 mv
8			Input Transformer	T1 pin 4	3 mv
9			Q1 Collector	Q1 case	690 mv
10			Q2 Collector	Q2 case	690 mv
11			Q3 Collector	Q3 case	242 mv
12			Q4 Collector	Q4 case	238 mv
13	(See Notes 7,8)		Output Transformer	T2 pin 3	675 mv
14			Output Transformer	T2 pin 4	3 mv
15			Output Transformer	T2 pin 5	675 mv
16			Output Transformer	T2 pin 2	950 mv

TABLE 5.2 RADIO FREQUENCY VOLTAGE CHART

STEP	DEVICE UNDER TEST	INPUT SIGNAL CONDITIONS	RF VOLTMETER MEASUREMENT (See Note 2)		
			LOCATION		TYPICAL INDICATION (See Note 3)
			DESCRIPTION	REF. DESIG.	
1	MC-1001 1:8 Divider (See Note 10)	(See Note 1)	Input	J2	200 mv
2			Transformer	T1 pin 2	144 mv
3			Transformer	T2 pin 3	143 mv
4			Transformer	T2 pin 3	145 mv
5	1:8 Divider (See Note 10)	(See Note 1)	Transformer	T3 pin 2	104 mv
6			Transformer	T4 pin 3	103 mv
7			Transformer	T4 pin 5	103 mv
8			Transformer	T5 pin 2	73 mv
9			Transformer	T6 pin 3	73 mv
10			Transformer	T6 pin 5	72 mv
11			Transformer	T7 pin 2	73 mv
12			Transformer	T8 pin 3	73 mv
13			Transformer	T8 pin 5	72 mv
14			Transformer	T9 pin 2	104 mv
15			Transformer	T10 pin 3	103 mv
16			Transformer	T10 pin 5	103 mv
17			Transformer	T11 pin 2	73 mv
18			Transformer	T12 pin 3	73 mv

TABLE 5.2 RADIO FREQUENCY VOLTAGE CHART

STEP	DEVICE UNDER TEST	INPUT SIGNAL CONDITIONS	RF VOLTMETER MEASUREMENT (See Note 2)		
			LOCATION		TYPICAL INDICATION (See Note 3)
			DESCRIPTION	REF. DESIG.	
19			Transformer	T12 pin 5	72 mv
20			Transformer	T13 pin 2	73 mv
21			Transformer	T14 pin 3	73 mv
22			Transformer	T14 pin 5	73 mv
1	MC-1003 1:8 Divider (See Note 10)	(See Note 1)	Input	J2	200 mv
2			Transformer	T1 pin 3	143 mv
3			Transformer	T1 pin 5	145 mv
4		(See Note 11)	Transformer	T2 pin 3	103 mv
5	(See Note 10)		Transformer	T2 pin 5	103 mv
6			Transformer	T4 pin 3	73 mv
7			Transformer	T4 pin 5	72 mv
8			Transformer	T5 pin 3	73 mv
9			Transformer	T5 pin 5	72 mv
10			Transformer	T3 pin 3	103 mv
11			Transformer	T3 pin 5	103 mv
12			Transformer	T6 pin 3	73 mv
13			Transformer	T6 pin 5	72 mv
14			Transformer	T7 pin 3	73 mv
15			Transformer	T7 pin 5	73 mv

NOTES FOR TABLE 5.2

(1) Use HP606A RF Generator or equivalent. Set controls to produce a 6 MHz un-modulated signal. For 75 ohm antenna couplers connect a 50:75 ohm matching pad at the generator output to produce a 75 ohm signal source and use 75 ohm cables.

(2) For the RF Voltmeter, use a Boonton 916A (or equivalent) with a Model 91-3C RF Probe and high impedance attachment. For convenience of testing, extend the ground lead on the probe to approximately two feet in length by adding a test clip lead. Place probe at points listed in LOCATION column; normal indications are listed in the next column.

(3) A tolerance on readings listed under TYPICAL INDICATION can generally be considered as ± 10%.

(4) Terminate all outputs and Input Test Point J2 in 50 or 75 ohm loads depending on characteristic of coupler under test. Make measurements with unit turned on and operating.

(5) Apply voltmeter probe at INPUT J1. Connect RF Generator to INPUT J1. Adjust generator signal level for 150 mv rms across input impedance of Antenna Coupler, as read on the voltmeter.

(6) Measure output voltages on circuit side of output connectors.

(7) All voltmeter measurements are made on component side (top side) of board.

(8) Adjust RF Generator level to give a 200 mv signal across T1 pin 2 to ground.

(9) Remove 1:8 Divider from Antenna Coupler, or if desirable, the 1:8 Divider may be tested in the chassis by disconnecting input cable 73-750164-1. As a safety precaution, remove input power cable to Antenna Coupler. Terminate all outputs.

(10) Adjust RF Generator level to give a 200 mv input signal across J1 connector.

TABLE 5.3 AC AND DC VOLTAGE CHART

STEP	DEVICE UNDER TEST	VOLTAGE MEASUREMENT (See Note 1)		SELECTOR SWITCH SETTING	TYPICAL INDICATION (See Note 2)
		POSITION (RED) PROBE LOCATION	NEGATIVE (BLACK) PROBE LOCATION		
1	Antenna Coupler	FL1 pin 1	GND	VDC1	120 VAC
2	(See Note 3)	FL1 pin 2	GND	VDC1	0
3		F1 Fuse	GND	VDC1	120 VAC
4		T1-3	GND	VDC1	120 VAC
5		A1-A	GND	VDC1	36VDC ± 4V
6		A1-L	GND	VDC1	24 ± .25VDC
7		A1-L	A5-R12 Board End	A3	0.75 VDC ±.2V
8		A2 Terminal 2	A2 Terminal 5	VDC1	0.75 VDC ±.2V
9		A5 pin 2	GND	VDC3	24.0 VDC
10	Amplifier Subassembly	pin 2	GND		24.0 VDC
11		T1 pin 5 (Q1 base)	GND		2.0 VDC
12		L_3 (Q1 emitter) (Q3 collector)	GND		1.4 VDC
13		Q1 case (collector)	GND		23.4 VDC
14		T1 pin 3 (Q2 base)	GND		2.0 VDC
15		L_4 (Q2 emitter) (Q4 collector)	GND		1.4 VDC
16		Q2 case (collector)	GND		23.4 VDC
17		T2 pin 5	GND		24.0 VDC
18		T2 pin 3	GND		24.0 VDC

NOTES FOR TABLE 5.3

(1) Use Triplett Volt-Ohm-Meter Type 630-A or equivalent. DO NOT use Differential Type Voltmeter to check DC voltages on Amplifier Sub-assemblies as this may destroy transistors.

(2) AC voltage tolerance is meter accuracy plus the ± 10% line voltage variation. The DC coltage tolerance is generally ± 4%, except where a range of values is so indicated.

(3) Apply 120 VAC prime power to FL1 J1 Power Input and terminate the eight outputs. Leave open Input J1. Turn power switch ON.

5.5 TROUBLE-SHOOTING CHART

A trouble-shooting chart for the Antenna Coupler is shown in Table 5.1. The chart lists typical trouble symptoms to aid the technician in Recognizing the Symptoms. The chart goes on Elaborating on the Symptoms, in the Analysis column. Finally, the chart provides, in support of the remaining steps of the logical trouble-shooting, a column that describes the Next Step in Localizing Trouble.

Use the trouble-shooting chart in conjunction with the Antenna Coupler overall functional schematic diagram (Figure 4.1). Also, refer as applicable to the individual subassembly schematics, and the supplementary data of Section 5.6.

5.6 SUPPLEMENTARY TROUBLE-SHOOTING DATA

To assist the trouble-shooting technician, supplementary data is presented in the form of charts and tables. This data includes the following:

a. RADIO FREQUENCY VOLTAGE CHART, TABLE 5.2

This chart lists RF voltage levels at significant points in the circuit when a 6 MHz RF signal is applied to the input. Data is given for the Antenna Coupler as a whole, and for the subassemblies when tested individually.

b. AC AND DC VOLTAGE CHART, TABLE 5.3

This chart lists voltage levels at significant points in the circuit when the unit is operating. The measuring instrument is a common Volt-Ohm-Meter. Data is given for the Antenna Coupler as a whole, and for the Amplifier Subassembly when tested alone.

c. AMPLIFIER SUBASSEMBLY PERFORMANCE LIMITS, TABLE 5.4

This Table lists the performance parameters and test limits when the Amplifier Subassembly is tested individually. Applicable test procedures in Section 6 are referenced for each parameter.

d. 1:8 DIVIDER PERFORMANCE LIMITS, TABLE 5.5

This Table lists performance parameters and test limits for the divider subassembly. Applicable test procedures in Section 6 are referenced for each parameter.

TABLE 5.4 AMPLIFIER PERFORMANCE LIMITS

ITEM	PARAMETER	TEST METHOD	LIMIT
1	Gain	Para. 6.4c(3) (d)	13 ± 1 db
2	Noise Figure	Para. 6.4c(3) (e)	6 db max
3	Input VSWR	Para. 6.4c(3) (c)	1.3:1 max
4	Output VSWR	Para. 6.4c(3) (c)	1.8:1 max
5	IM	Para. 6.4c(3) (b)	Second & Third Order: 80 db min. (See Table 6.1)
6	Phase Tracking (MC-1004 Only)	Para. 6.4c(3) (f)	± 1° max against phase standard

TABLE 5.5 1:8 DIVIDER PERFORMANCE LIMITS

ITEM	PARAMETER	A8 - 1:8 DIVIDER	
		LIMIT	TEST METHOD
1	Insertion Loss	9.5 ± 0.2db at 1.5 MHz 10.0 ± 0.2db at 30 MHz	Para. 6.4c(5)(d)
2	VSWR (All Ports)	1.25:1 max	Para. 6.4c(5)(c)
3	Isolation (Between Outputs)	40db min.	Para. 6.4c(5)(a)
4	Phase Tracking	+ - 1° against Phase Standard	Para. 6.4c(5)(b)

SECTION 6

REPAIR

6.1 GENERAL

This section covers all areas of repair for the Antenna Coupler. Detailed instrcutions are presented on testing the Antenna Coupler, particularly its subassemblies. Block diagrams showing equipment test setups are used to support the test procedure.

6.2 REMOVAL AND REPLACEMENT INSTRUCTIONS

Since the Antenna Coupler design is based on a modular approach, the replacement of subassemblies and major components is relatively easy; however, detailed instructions are listed a through f to aid the repair technician.

a. Removal and Replacement of Plug-In Subassemblies

The Amplifier Subassembly is mounted on the chassis with screws. Removal ofthis module is accomplished by removing the screws in the base plate, and disconnecting the power and RF connections.

b. Removal and Replacement of 1:8 Power Divider

The 1:8 Divider Subassembly can be removed from the chassis frame as follows:

Disconnect the coaxial cable at the input (J1), remove the screws holding the assembly to the internal frame, remove the screws holding the assembly to the rear panel, and lift out the 1:8 Divider. Installation is the reverse sequence.

c. Removal and Replacement of Power Supply

To remove the Power Supply regulator from the Antenna Coupler, pull evenly upward.

d. Removal and Replacement of Hybrid Transformers

The transformers are removed as follows:

Unsolder all wires to the transformer terminals.

e. Removal and Replacement of Transistors

Remove the transistor from the socket by pulling upward. No unsoldering is required. Transistor replacement is in the reverse sequence.

Mark or number the transistor that has been removed so that it can be returned to the same socket if desired. Note that if a transistor is replaced or is moved to a different socket, the Amplifier Subassembly must be realigned for minimum IM.

CAUTION

Q1 and Q2 type transistors are not interchangeable with Q3 and Q4 type transistors.

NOTE

Before replacing transistors in an Amplifier Subassembly, always test all four transistors for opens and shorts using a transistor tester. Certain open and short conditions in Q3 or Q4 will automatically destroy the respective first stage transistor, Q1 or Q2. The detrimental conditions in Q3 or Q4 are: Collector to base short, collector to base open, and emitter to base open.

6.3 TESTING INSTRUCTIONS

a. General

The purpose of this section is to discuss test procedures for the Antenna Coupler and its subassemblies. It is assumed that all troubleshooting has been performed and the defective part repaired or replaced. We are ready, therefore, to check out the unit for satisfactory operational performance. After repair of any RF component, its subassembly must be tested, then the whole Antenna Coupler must be tested. To assist in obtaining optimum performance, adjustments have been provided for several parameters. Adjustments for minimizing IM should only be attempted when measuring the Amplifier Subassemblies. Output to output isolation and phase tracking for each output are normally adjusted when testing the 1:8 Divider, but may require slight readjustment at the Antenna Coupler level.

Equipment and tools required to perform these tests are listed in Tables 1-2 and 1-3.

When an Antenna Coupler or a subassembly is repaired for a specific parameter, not only must that parameter be tested as part of the checkout, but also all other performance parameters. Many of the parameters and circuit functions are inter-related. Quick spot checks may be used on parameters obviously not affected by the repair process. A maintenance and test log should be kept for all Antenna Couplers and subassemblies tested in the Repair Area.

b. Antenna Coupler Test Equipment

All performance tests on the Antenna Coupler may be performed in conjunction with standard test equipment listed in Table 1-3. Study operating manuals for all test equipment before attempting tests described below.

c. Tests and Adjustments

(1) Selection of Gain and Phase Tracking Standards

In some applications gain and phase tracking performance between Antenna Couplers may be important. To test for tracking, a reference standard is required for the Amplifier Subassembly, and 1:8 Divider. The easiest and most logical standard is another subassembly of the same type, with known performance relative to the performance distribution of all subassemblies. It must be remembered that for tracking parameters absolute numbers are irrelevant; it is the total spread or difference among all units that is important.

The following technique is recommended for selecting reference standards: Measure the relative amplitude and phase characteristics of 10 to

20 pieces of the same subassembly, that are known to be in good working order. Plot the data distribution for performance versus number of units. Repeat this process for each test frequency. Apply the subassembly tracking limit listed in Tables 5-4 (or Table 5-5, if applicable) to the center of the distribution to accept the greatest number of units tested. Mark and record the end limits for each frequency. Select a subassembly near the center of the limits, and call this the reference standard. Tag this subassembly with its recorded readings and with the allowable plus and minus deviation between its performance and the accepted limits. All future units tested will be compared to this reference standard.

As more distribution information is made available through routine testing, it may be necessary to move the tracking limits to new absolute numbers in order to accept the greatest number of units. The tracking tolerance or spread, however, must remain unchanged.

(2) Amplifier Tests

(a) IM ADJUSTMENT - Perform this adjustment using the test setup shown in Figure 6-1. The following steps serve as a guide:

CAUTION

Use good RF measurement practices for all tests and be certain impedances are proper for all equipments involved. Note that multicouplers may be 50 or 75 ohms depending on user requirements.

Step 1 - Adjust the test equipment so that each input signal is .25 VRMS at the desired amplifier input terminal as measured by the RF voltmeter.

Step 2 - Adjust the two potentiometers, R7 and R10, to minimize the level of the second and third order products. The IM products must be adjusted to within the limits specified in Table 6-1, and in accordance with the procedure described below. Normally, if adjustments are made on the 30 MHz products, other frequencies will be within the specification.

CAUTION

During the course of transistor replacement certain combinations of transistors will be found which will not permit the Amplifier Subassembly to be adjusted within specification requirements. Should this situation occur, interchange Q1 and Q2 and readjust the potentiometer settings for minimum IM levels. Should this prove inadequate, return Q1 and Q2 to their original positions and interchange Q3 and Q4. Readjust the potentiometers for minimum IM levels. Occasionally this may still prove inadequate, and a new transistor may be used to form a new Q1-Q2 pair. Very rarely is a new Q3-Q4 pair required. DO NOT THROW AWAY the replaced transistor unless it is obviously defective for reasons other than poor IM performance. It is very likely this transistor will operate satisfactorily with a new mate.

(b) IM TEST - Perform the IM test for adjustment purposes according to the following procedure:

Step 1 - Connect test equipment as shown in Figure 6-1.

Step 2 - Connect output of Power Combiner to multicoupler input.

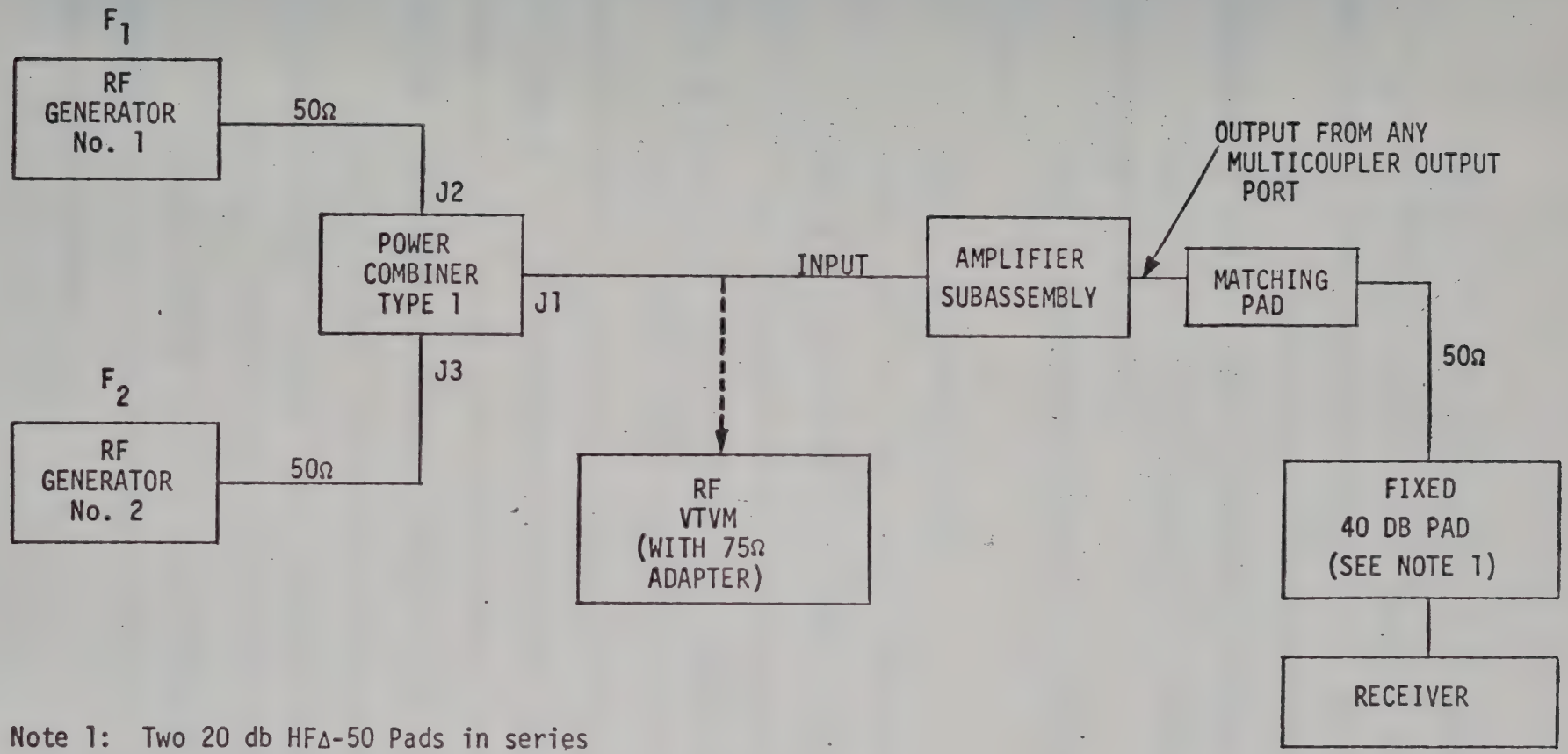
Step 3 - Tune RF Generator No.1 FREQUENCY control to F1, and RF Generator No. 2 FREQUENCY control to F2, as specified in Step 1 of Table 6-1.

TABLE 6-1 AMPLIFIER SUBASSEMBLY INTERMODULATION DISTORTION LIMITS

STEP	PRIMARY FREQUENCY		PRODUCT FREQUENCY F3 (MHz)	LEVEL LIMIT (db) MINIMUM
	F1 (MHz)	F2 (MHz)		
1	28.0	26.0	2.0	-80
2	26.0	12.0	14.0	-80
3	18.0	12.0	30.0	-80
4	10.0	22.0	2.0	-80
5	10.0	12.0	14.0	-80
6	22.0	26.0	30.0	-80

Note: • Input signal level at F1 and F2 is 250 mv rms

• IM levels are in DB below amp output for a single .25v rms input



Note 1: Two 20 db HFΔ-50 Pads in series

Note 2: Adjust impedance levels in accordance with impedance of unit under test.

Figure 6-1. INTERMODULATION TEST BLOCK DIAGRAM FOR AMPLIFIER SUBASSEMBLY

Step 4 - Turn RF Generator No. 1 ATTENUATOR control to -60 DBM and adjust ATTENUATOR and VERNIER of RF Generator No. 2 for 250 millivolts RMS on the RF VTVM at the input (T1, pin 2) to amplifier module under test.

Step 5 - Note position of RF Generator No. 2 ATTENUATOR and turn ATTENUATOR to -60 DBM, without disturbing the VERNIER setting.

Step 6 - Adjust RF Generator No. 1 ATTENUATOR and VERNIER for 250 millivolts RMS on the RF VTVM.

Step 7 - Adjust RF Generator No. 2 ATTENUATOR back to setting noted in Step 5.

Step 8 - Disconnect RF VTVM.

Step 9 - Position SIGNAL INPUT ATTENUATOR of Receiver to 0 db.

Step 10 - Tune Receiver to F3 (Step 1, Table 6-1). Adjust TUNING control for a peak indication on the Receiver output meter, if necessary using IF GAIN control to maintain on-scale indication.

Step 11 - Verify proper system tuning to F3 by alternately decreasing F1 and F2 10 db by means of respective ATTENUATOR controls on RF Generators No. 1 and No. 2. This should cause the Receiver output level to decrease a minimum of 10 db. Do not touch VERNIER controls on RF Generators. Return Generator ATTENUATOR controls to original settings of Step 7.

Step 12 - Adjust the Receiver IF GAIN control for convenient Receiver output meter reading. This is the reference reading.

Step 13 - Rotate Receiver SIGNAL INPUT ATTENUATOR to 80 db.

Step 14 - Set RF Generator No. 2 FREQUENCY to F3 and adjust the FREQUENCY control for a peak indication on Receiver output meter. DO NOT VARY ANY OTHER CONTROLS.

Step 15 - Recalibrate RF Generator No. 2 for 250 millivolt RMS as per Steps 2 and 4.

Step 16 - Disconnect RF VTVM.

Step 17 - Recheck for peak indication on Receiver output meter by carefully adjusting FREQUENCY VERNIER on Generator No. 2. Observe and record db indication on black scale of Receiver output meter.

Step 18 - Add Receiver output meter db indication to SIGNAL INPUT ATTENUATOR setting (i.e., 80 db) and subtract 10 db from this sum. This is the IM Distortion level of Amplifier Subassembly for frequencies F1 and F2.

Step 19 - Repeat Steps 2 through 18 for each of the remaining five steps listed in Table 6-1. Acceptable performance limits for each frequency combination are also listed in Table 6-1.

(c) VSWR TEST - Perform the VSWR test according to the following procedure:

Step 1 - Connect test equipment as shown in Figure 6-2.

Step 2 - Adjust Oscilloscope and Sweep Generator for a visible sweep pattern.

Step 3 - Place the 2.0 MHz FIXED MARKER switch in the ON position. Adjust SWEEP and SWEEP WIDTH controls of Sweep Generator to display the frequency band under test on the Oscilloscope.

Step 4 - Set MILLIVOLTS/ON control on the Oscilloscope to the 1 MILLIVOLT/ON position.

Step 5 - Adjust Oscilloscope HORIZONTAL POSITION control to position marker at center of screen graticule.

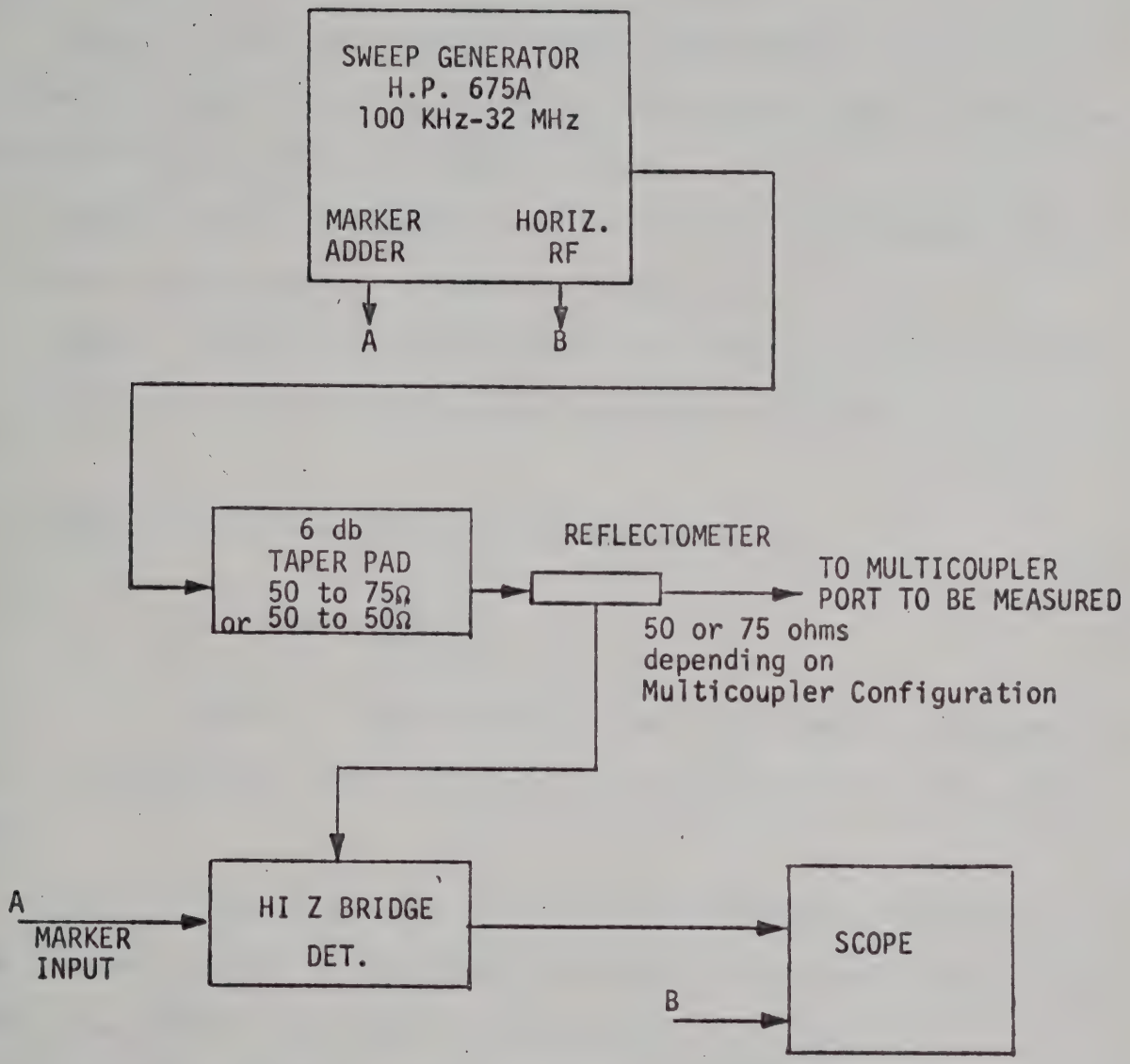


Figure 6-2 STANDARD VSWR TEST SETUP

Step 6 - Disconnect Reflectometer from Subassembly under test and leave open circuited. Switch off FIXED MARKER.

Step 7 - Adjust Oscilloscope VARIABLE MV/ON control to obtain a pattern showing a peak to peak ripple of four centimeters vertical deflection. four centimeters equals 20 small screen divisions.

Step 8 - Without disturbing Oscilloscope and Sweep Generator controls, reconnect Reflectometer to Subassembly under test.

Step 9 - Observe and record peak to peak height of ripple pattern, in small divisions, nearest to the marker frequency on the oscilloscope graticule.

Step 10- Calculate VSWR from the formula

$$VSWR = \frac{20 + A}{20 - A}$$

where A = ripple height in small divisions as recorded in Step 9. This calculation gives the Input VSWR of the Amplifier Subassembly at 1.5 MHz.

Step 11- Repeat Steps 8, 9 and 10 with Reflectometer connected to Subassembly Output and the desired load connected to Subassembly Input. This gives the Output VSWR of the Amplifier Subassembly at 1.5 MHz.

Step 12- Repeat Steps 3 through 11 for test frequencies of 6 MHz, 12 MHz, 18 MHz, 24 MHz, and 30 MHz. Acceptable VSWR performance limits are listed in Tables 5-4 and 5-5.

(d) GAIN TEST - Perform the gain test according to the following procedure:

Step 1 - Connect test equipment as shown in Figure 6-3. Disconnect the 1:8 Power Divider Input and use this cable as output for gain tests.

Step 2 - Set RF VTVM to 0.3 volt range.

Step 3 - Set RF Generator FREQUENCY control to 1.5 MHz.

Step 4 - Connect Cable No. 1 to Cable No. 2 through UG 914/U Adapter.

Step 5 - Set Variable Attenuator to 5.0 db.

Step 6 - Adjust RF Generator ATTENUATOR and VERNIER controls for an indication of 0.29 volt on RF VTVM.

Step 7 - Set Variable Attenuator to 18.0 db.

Step 8 - Remove UG 914/U Adapter and connect Cables to Subassembly Under Test as shown in Figure 6-3.

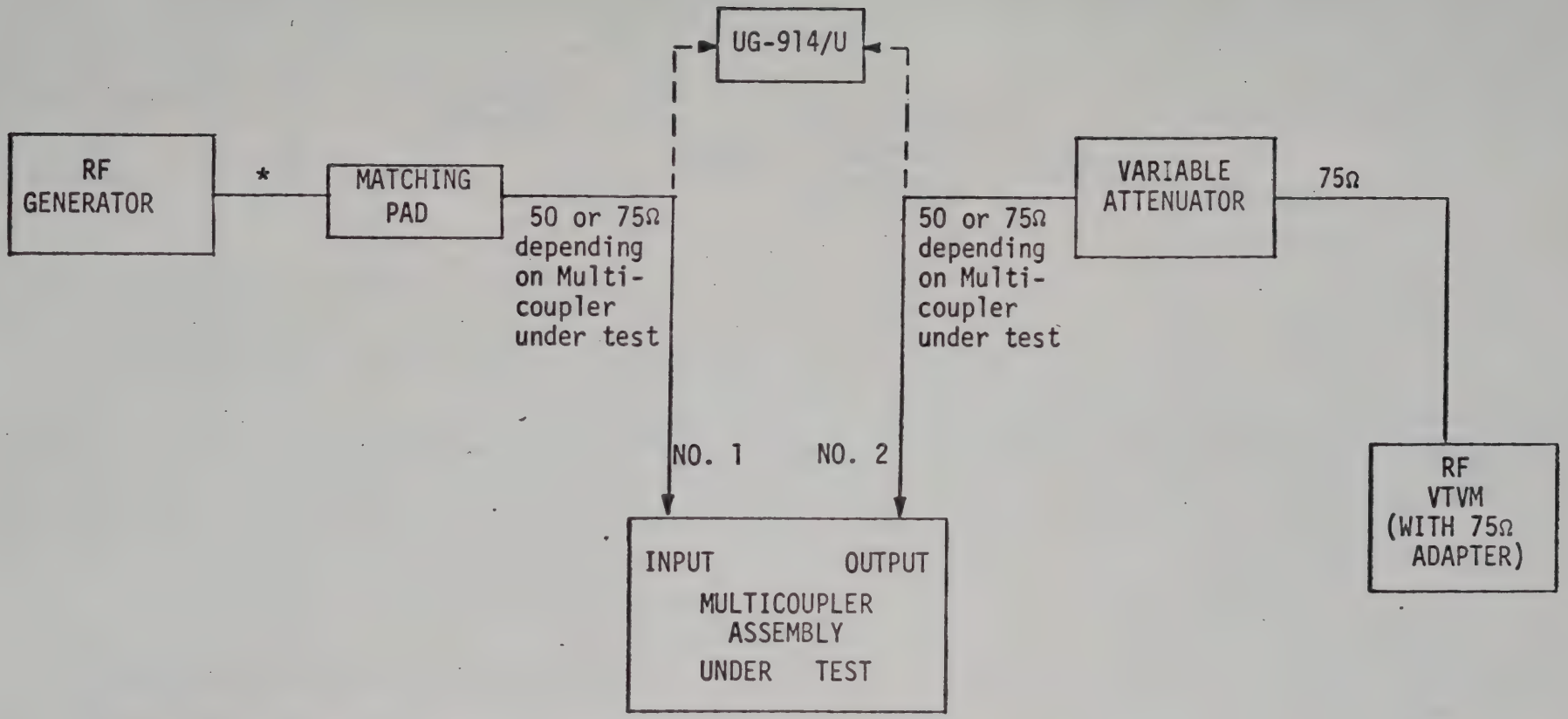
Step 9 - Observe RF VTVM and adjust Variable Attenuator to obtain 0.29 volts on RF VTVM as in Step 6.

Step 10 - Calculate Amplifier Subassembly gain at 1.5 MHz by subtracting 5 db from final setting of Variable Attenuator.

Step 11 - Repeat Steps 3 through 10 for test frequencies of 6 MHz, 12 MHz, 18 MHz, 24 MHz, and 30 MHz.
Applicable gain performance limits are listed in Table 5-4.

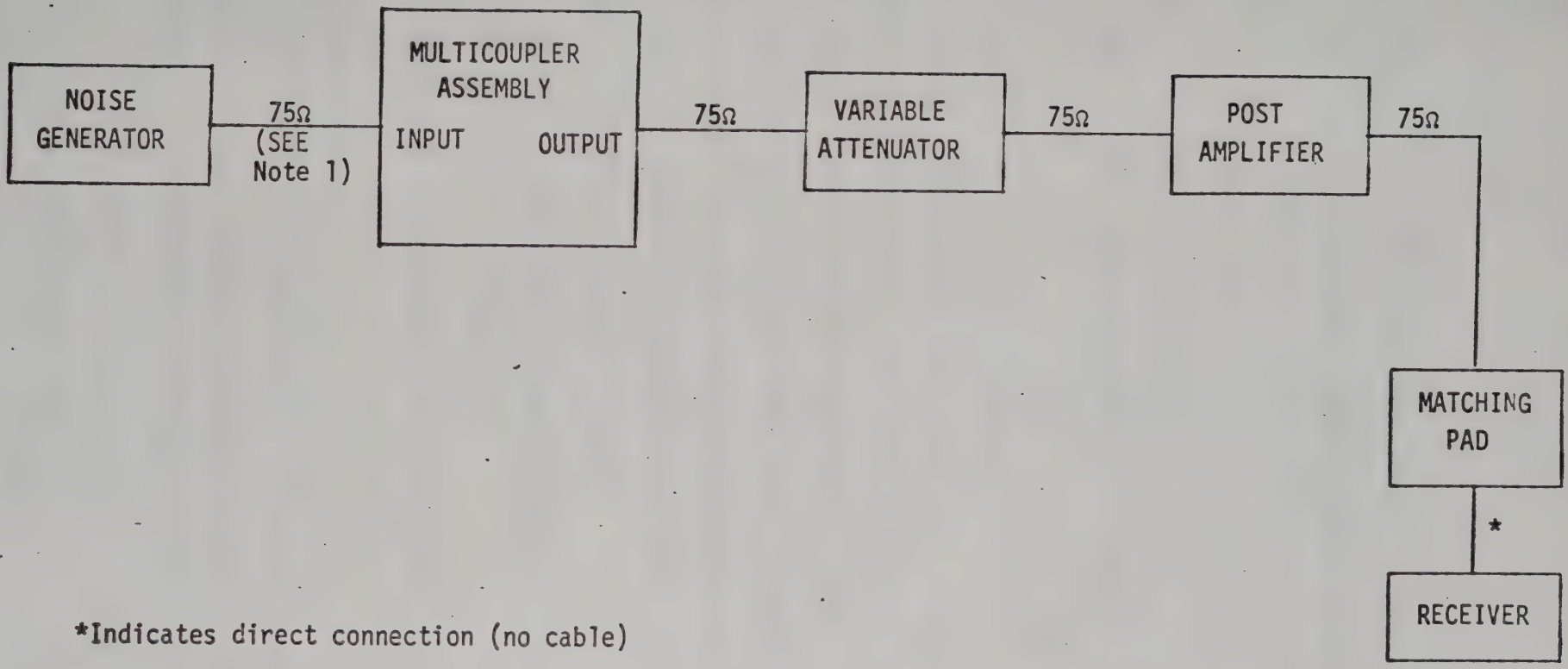
(e) NOISE FIGURE TEST - Perform the noise figure test according to the following procedure:

Step 1 - Connect test equipment as shown in Figure 6-4. Disconnect the 1:8 Power Divider and use the disconnected cable as the output for this measurement. Be sure all amplifier subassemblies are inserted.



*Indicates direct connection (no cable)

Figure 6-3 GAIN AND INSERTION LOSS TEST BLOCK DIAGRAM



*Indicates direct connection (no cable)

Note 1: This cable length should not exceed 12 inches

Figure 6-4 NOISE FIGURE TEST BLOCK DIAGRAM

Step 2 - Set Noise Generator controls to following positions:

OUTPUT ADJUST: Maximum Counterclockwise

POWER: ON

DIODE: OFF

METER MULTIPLIER: X1

Step 3 - Set Receiver TUNING to 1.5 MHz and SIGNAL INPUT ATTENUATOR to 20 db.

Step 4 - Set Variable Attenuator to 0 db.

Step 5 - Adjust Receiver IF GAIN for indication of 8 db on black scale of Receiver Output meter. This is the reference setting.

Step 6 - Set Variable Attenuator to 3 db.

Step 7 - Set Noise Generator DIODE to ON and vary OUTPUT ADJUST until Receiver output indication returns to reference setting of 8 db.

Step 8 - Observe and record Noise Figure from noise generator meter. This is the Noise Figure at 1.5 MHz.

Step 9 - Repeat Steps 2 through 8 for test frequencies of 6 MHz, 12 MHz, 18 MHz, 24 MHz, and 30 MHz.

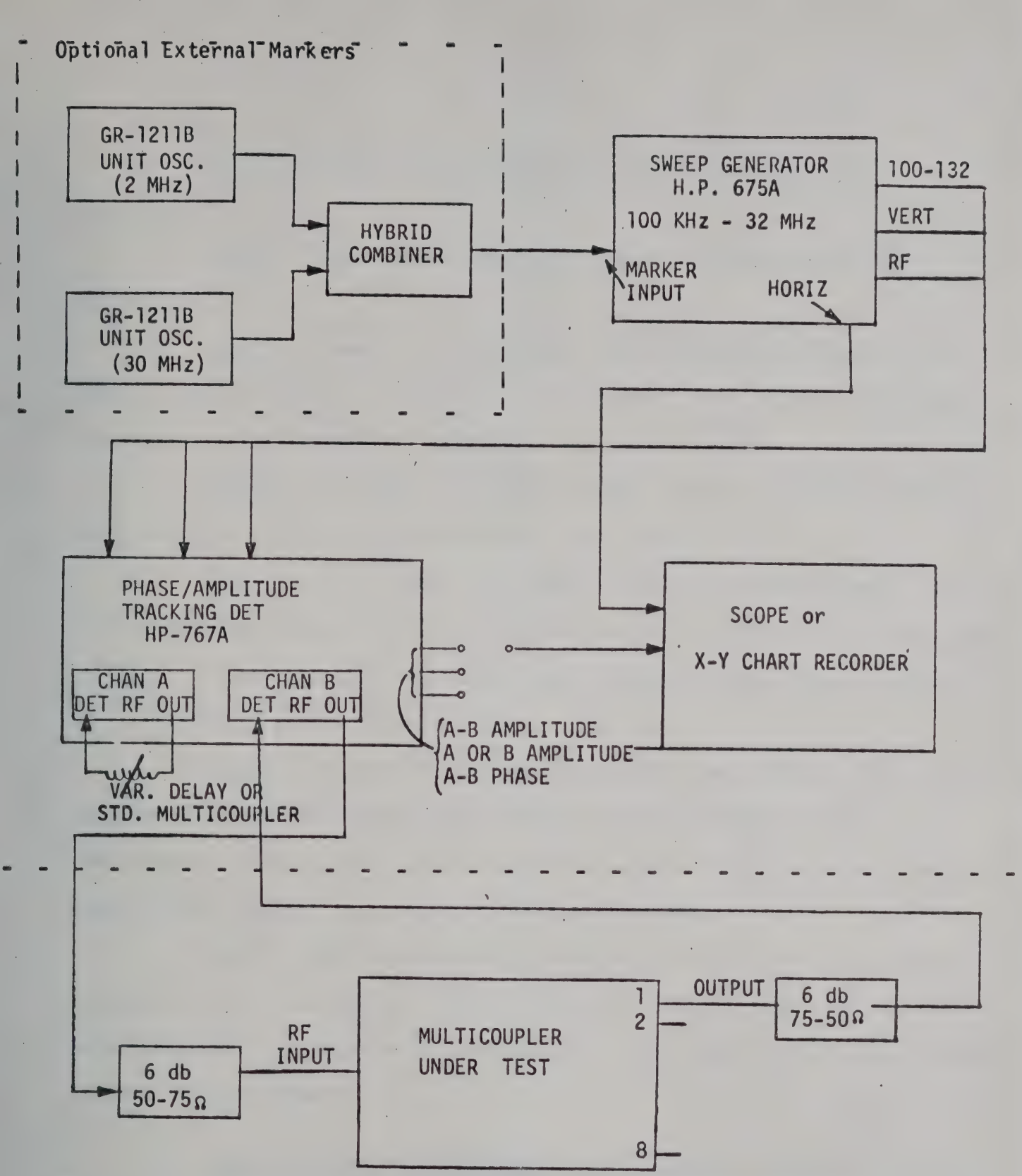
Acceptable noise figure performance limits are shown in Table 5-4.

(3) 1:8 Divider Test

(a) ISOLATION TEST AND ADJUSTMENT - Perform the adjustment and measurement of output to output isolation according to the following procedure:

Step 1 - Connect test equipment as shown in Figure 6-5.

Connect each test probe to a selected output, terminate the input of the multicoupler under test.



Note: Adjust Impedance levels in accordance with unit under test.

Figure 6-5 STANDARD AMPLITUDE AND PHASE TEST SETUP

Step 2 - Adjust sweep generator to cover the range from 1.5 MHz to 30 MHz.

Step 3 - Adjust sweep generator output to approximately 100 millivolts.

Step 4 - Connect the two signal probes together and obtain reference lines on the oscilloscope at 10 db intervals from 0 to 50 db in conjunction with the attenuator control on the sweep generator.

Step 5 - Terminate all outputs except two under test and connect test probes to these two outputs starting with outputs 1 and 2.

Step 6 - Observe that the output isolation between outputs 1 and 2 as observed on the oscilloscope is below the -40 db reference line obtained earlier. Trimmer capacitor associated with outputs 1 and 2 may be adjusted by isolation not greater than 40 db.

Step 7 - Continue testing and adjusting (see schematic for proper adjustment, Reference Designation) between adjacent outputs moving in turn from outputs 1 and 20, to 3 and 4, to 5 and 6, and then to 7 and 8. Always keep untested outputs terminated in a proper impedance.

Step 8 - Continue checking isolation between various outputs until all combinations provide isolation in excess of -40 db. Some back and forth adjustments will be required to maintain isolation since interaction may occur between various outputs.

(b) PHASE TRACKING AND ADJUSTMENT (MC 1004 Only) - Perform the adjustment and measurement of phase tracking according to the following procedures:

Step 1 - Connect test equipment as shown in Figure 6-5.

Step 2 - Insert an appropriate piece of coaxial cable to use as a phase tracking reference.(Select a cable that provides a convenient scope scale factor). Insert the reference cable between the Channel A detector and Channel A output of the phase amplitude tracking detector.

Step 3 - Operate multicoupler in its normal mode and observe the degree of phase tracking between each output by successively moving the output probe through outputs 1 through 8. Each output should track phase within $\pm$ 1 degree. If any output fails to track, adjust the trimmer capacitor immediately adjacent to the output coaxial connector involved until proper tracking is obtained.

SECTION 7 - PARTS LIST

UNIT & NAME REF DESIG. PRE-FIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
MULTICOUPLER MC1002	A1	24 volt Power Supply Regulator	Aiken Elec.	22-0018
NOTE:A2,A3,A4,A6	A5	Basic Amplifier Module	Aiken Elec.	34-0069-9
and A7 NOT	A8	1:8 Non Phase Tracking Power Divider 50Ω		34-0029-2
used in		75Ω		34-0029-1
this model	A9	High Level Protector Module 75Ω		22-0105-2
		50Ω		22-0105-1
	Q1	Transistor, NPN Silicon	--	2N3055
	T1	Transformer, Power	Freed	40613
	S1	Switch, Toggle	Cutler H.	8 363-K7
	S2	Switch, Slide	Switch Craft	46206LF
	XDS-1	Pilot Light	Dialco	508-7538-504 & 3917-1471-600
	XF-1	Fuseholder	Littelfuse	342004
	FL1	RFI Line Filter	Aiken Elec.	
	C1	Capacitor, Filter, 500μFD, 50v	Sprague	T VL-L330

UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
Part #22-0018	R1	Resistor, 2.1Ω, ± 5%,1/2W	--	RC20GF2R7J
POWER SUPPLY REGULATOR A1	R2	Resistor, 2K, ± 5%, 1/4W	--	RC07GF202J
	R3	Resistor 22K ± 5% 1/4W	--	RC07GF223J
	R4	Resistor, 47K, ± 5%, 1/4W	--	RC07GF473J
	R5	Pot 2K	Bourns	3067P-1-202
	R6	Resistor 6.8K ± 5%, 1/4W		RC07GF682J
	R7	Same as R1		
	R8	Resistor 2.4K, ± 5%, 1/4W	--	RC07GF242J
	R9	Resistor 680Ω, ± 5%, 1/2W	--	RC20GF681J
	C1	Capacitor, .1μf 200V	Sprague	192P-10492
	C2	Same as C1		
	C3	Same as C1		
	C4	Capacitor 33μf 35V	Sprague	CSR13F336KL
	C5	Capacitor .1μf 100V	Sprague	TGS10
	I1	Integrated Regulator	Motorola	MC1461R
	CR1	Diode		1N645
	CR2	Diode,		1N3032B
	BR1	Diode Bridge	Elec. Devices	PD-10
	Q1	Transistor		2N2219

UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
Part #34-0069-9	R1	Resistor, 430Ω 5%, 1/4W	--	RC07GF431J
BASIC AMPLIFIER MODULE	R2	Resistor, 464Ω, ± 1%, 1/4W	--	RN60D4640RF
A5	R3	Resistor, 2.2K, ± 5%, 1/2W	--	RC20GF222J
	R4	Resistor, 169Ω, ± 5%, 1/4W	--	RC07GF169J
	R5	Same as R2		
	R6	Resistor, 4.7Ω, ± 5%, 1/2W	--	RC20GF4R1J
	R7	Potentiometer, 20Ω	Spectral	53-1-1-200
	R8	Resistor, 15.4Ω, ± 1%, 1/2W	--	RN65D15R4F
	R9	Same as R8		
	R10	Same as R7		
	R11	Same as R6		
	R12	Resistor, 10K, ± 5%, 1/2W	--	RC20GF103J
	R13	Same as R12		
	R14	Not used		
	R15	Not Used		
	R16	Resistor, 51Ω, ± 5%, 1/4W	--	RC07GF510J
	R17	Same as R16		
	R18	Not used		
	R19	Resistor 820Ω, 5%, 1/4W	--	RC07GF821J
	R20	Same as R19		
	C1	Capacitor, .022µfd, 200V	Sprague	192P22392
	C2	Same as C1		
	C3	Same as C1		

UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
BASIC AMPLIFIER MODULE A5 Cont.	C4	Capacitor, 8.2pf	--	301-000-C0H01 00C
	C5	Not used		
	C6	Not used		
	C7	Not used		
	C8	Not used		
	C9	Capacitor, 160pf ± 5%		CM05FD161J03
	C10	Same as C9		
	C11	Capacitor 1pf		DM5CC010A
	C12	Same as C11		
	C13	Not used		
	C14	Same as C4		
	CR1	Diode		1N645
		Ferrite Beads (large hole)		K00100/3B

UNIT & NAME REF DESIG. PRE-FIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
Part # 34-0029-2	C1	Capacitor, 8.2pf 500V,2%	--	301-000-C0H01(
1:8 NON-PHASE TRACKING POWER DIVIDER, 50Ω A8	C2	Capacitor, .022µf, ± 10%, 200v	Sprague	192P22392
	C3	Same as C1	--	
	C4	Same as C2		
	C5	Capacitor, 18pf, ± 2%, 500V		CC20CH180G
	C6	Capacitor, 12pf, ± 2%, 500V		CC20CH120G
	C7	Capacitor, 5.5-18pf variable	JFD	DV-11PS-18A
	C8	Same as C7		
	C9	Same as C7		
	C10	Same as C7		
	C11	Same as C7		
	C12	Same as C7		
	C13	Capacitor, 6pf, ± 2%		CC22CH060C
	C14	Same as C13		
	C15	Same as C13		
	C16	Same as C13		
	C17	Same as C1		
	C18	Same as C1		
	C19	Same as C1		
	C20	Same as C1		
	C21	Same as C1		
	C22	Same as C1		
	C23	Same as C1		

UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
1:8 NON-PHASE TRACKING POWER DIVIDER, 50Ω	C24	Same as C1		
	C25	Capacitor .01μf		CK63
A8 -Cont	R1	Resistor, 3.9KΩ, ± 5%, 1/2W	--	RC20GF392J
	R2	Resistor, 37.4Ω,± 1%, 1/2W	--	RN60D37R4F
	R3	Resistor, 1 ,± 5%, 1/2W	--	RC20GF100J
	R4	Resistor, 1.2K,± 5%, 1/2W	--	R220GF122J
	R5	Same as R2		
	R6	Same as R3		
	R7	Same as R3		
	R8	Same as R4		
	R9	Same as R2		
	R10	Same as R3		
	R11	Same as R2		
	R12	Same as R2		
	R13	Same as R2		
	R14	Same as R2		
	T1-T7	Transformer, 75:75 Ω	Aiken Elec.	22-104
	J1	Connector, BNC		UG-535/U
	J2-J9	Connector RF,TNC,BNC,C or other		Various (See Unit)

UNIT & NAME REF DESIG. PRE-FIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
Part #34-0029-1	C1	Capacitor, 8.2pf, 500V 2%	--	301-000C0H0100C
1:8 NON-PHASE TRACKING POWER DIVIDER, 75Ω A8	C2	Capacitor, .022µf, ± 10%, 200v	Sprague	192P22392
	C3	Same as C1	--	
	C4	Same as C2		
	C5	Capacitor, 18pf, ± 2% 500V		CC20CH180G
	C6	Capacitor, 12pf, ± 2% 500V		CC20CH120G
	C7	Capacitor, 5.5-18pf variable	JFD	DV-11PS-18A
	C8	Same as C7		
	C9	Same as C7		
	C10	Same as C7		
	C11	Same as C7		
	C12	Same as C7		
	C13	Capacitor, 6pf, ± 2%		CC22CH060C
	C14	Same as C13		
	C15	Same as C13		
	C16	Same as C13		
	C17	Same as C1		
	C18	Same as C1		
	C19	Same as C1		
	C20	Same as C1		
	C21	Same as C1		
	C22	Same as C1		
	C23	Same as C1		

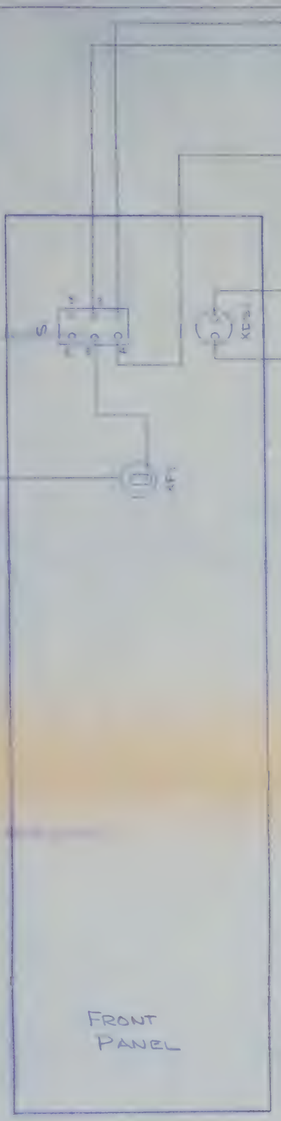
UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
1:8 NON-PHASE TRACKING POWER DIVIDER, 75 Ω	C24	Same as C1		
	C25	Capacitor .01μf		CK63
A8 -Cont	R1	Resistor, 3.9KΩ, ± 5%, 1/2W	--	RC20GF392J
	R2	Resistor, 37.4Ω, ± 1%, 1/2W	--	RN60D37R4F
	R3	Resistor, 1 , ± 5%, 1/2W	--	RC20GF100J
	R4	Resistor, 1.2K, ± 5%, 1/2W	--	R220GF122J
	R5	Same as R2		
	R6	Same as R3		
	R7	Same as R3		
	R8	Same as R4		
	R9	Same as R2		
	R10	Same as R3		
	R11	Same as R2		
	R12	Same as R2		
	R13	Same as R2		
	R14	Same as R2		
	T1-T7	Transformer, 75:75 Ω	Aiken Elec.	22-104
	J1	Connector, BNC		UG-535/U
	J2-J9	Connector RF,TNC,BNC,C or other		Various (See Unit)

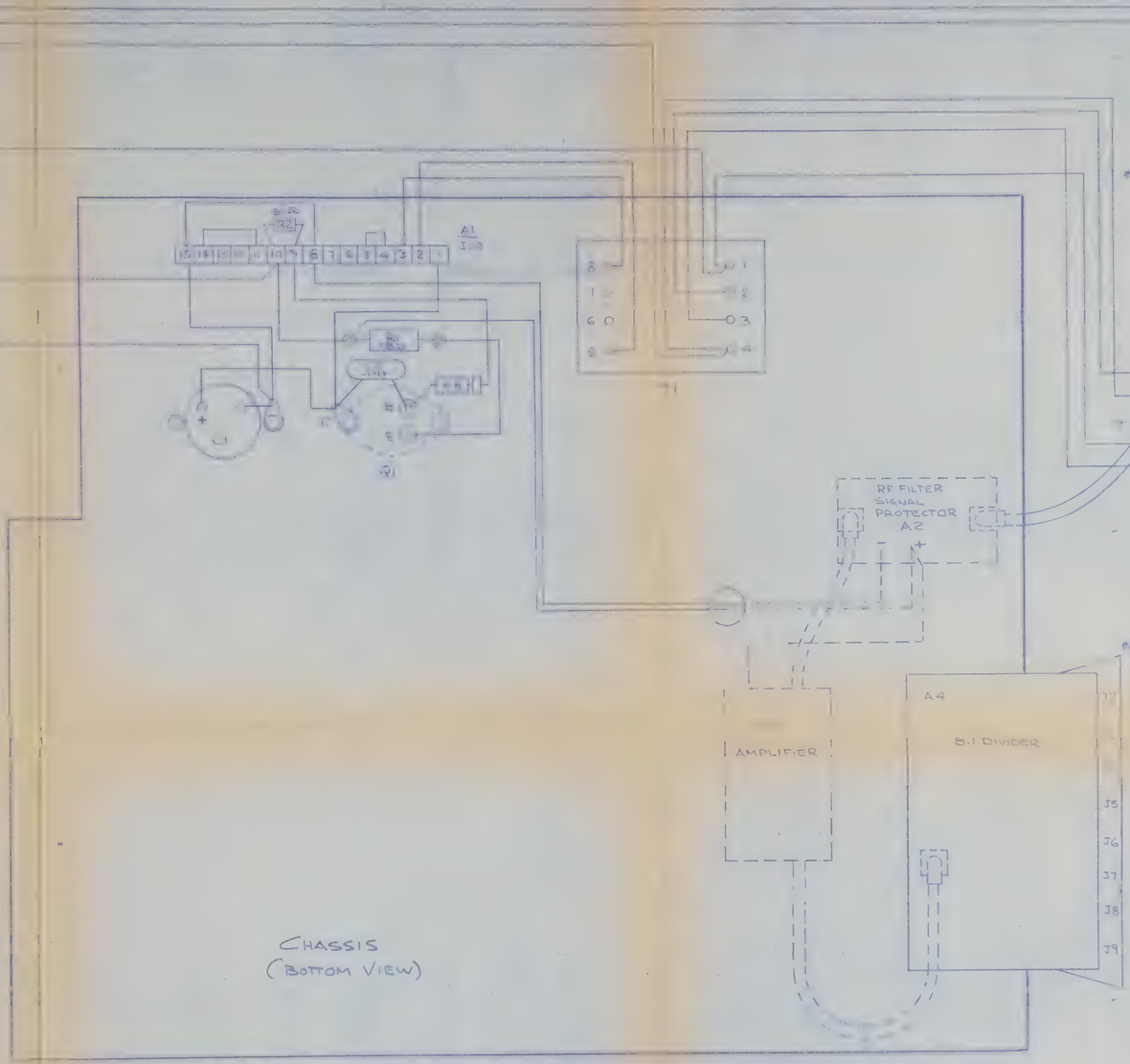
UNIT & NAME REF DESIG. PREFIX	REF DESIG.	DESCRIPTION	VENDOR	PART NUMBER
Part #22-0105-1	R1	RESISTOR, 10K, ±5%, 1/4W	--	RC07GF103J
HIGH LEVEL PROTECTOR 50Ω	R2	Same as R1		
	R3	Resistor, 2K, ± 5%, 1/4W	--	RC07GF202J
	R4	Resistor, 3K, ± 5%, 1/4W	--	RC07GF302J
	R5	Resistor, 390 Ω, ± 5%,1/4W	--	RC07GF391J
	C1	Not Used		
	C2	Capacitor, 100pf	--	CM05F101J03
	C3	Same as C2		
	C4	Capacitor, 220µf 15VDC	--	69F2236-01
	C5	Capacitor, 3.3µf, 35 VDC	--	CSR13G335KL
	C6	Capacitor, 82pf	--	CM05ED820J03
	K1	Relay, 5PST	Allied Control	RD-1A
	CR1	Diode Silicon		1N645
	Q1	Transistor, Silicon NPN		2N2219
	L1	Inductor, RF .15µhy	Aiken Elec.	
	L2	Inductor, RF .025µhy	Aiken Elec.	
	L3	Inductor, RF .35µhy	Aiken Elec.	
	L4	Inductor, .1µhy	Aiken Elec.	
	L5	Industor, RF .3µhy		

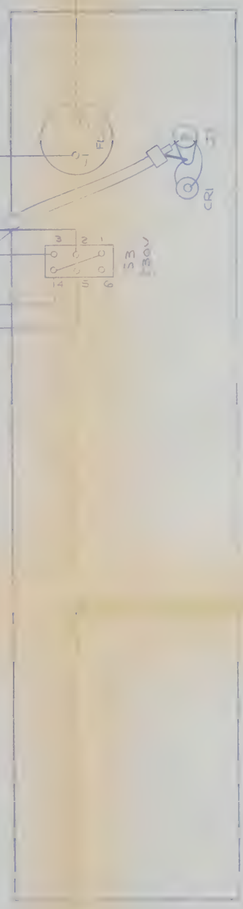
AIKEN ELECTRONICS DRAWINGS:

DRAWING NO.	
34-0079	WIRING DIAGRAM H.F. MULTICOUPLER - MC1002
34-0059	8:1 DIVIDER (75/50Ω)
34-0013	1:8 DIVIDER (75/70Ω)

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD







QTY REQD	QTY REQD	SYM	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
—2	—1							

LIST OF MATERIALS

P/G	USED ON	NEXT ASSY
APPLICATION		

FINISH:

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ON: FRACTIONS DECIMALS ANGLES ± ± ±

MATERIAL:

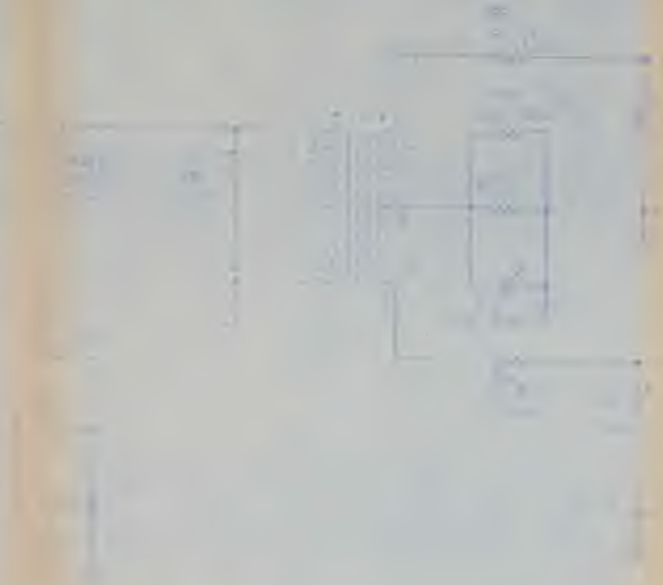
SIGNATURE	DATE
DR R SCELSI	2/1/51
DWG SUP	
CHK	
DES ENGR	
ENGR	
ENGR	
PROJ	
APPD	

AIKEN ELEC

WIRING DIAGRAM
H.F. MULTICOUPLER
MC1002 W/1 A1003-4

CODE IDENT NO	SIZE	
	D	24-00371

SCALE SHEET



AIKEN ELECTRONICS
MULTICOUPLER TEST DATA SHEET

MODEL NUMBER Mc 1002
SERIAL NUMBER 130-5008
TEST ENGINEER EWM
DATE 5-13-71 (K I-6)

GAIN: 2 ± 1.0 db
FREQ. RANGE: 2MHz to 32MHz
MEASUREMENT FREQ: F1=2 F2=6 F3=12 F4=18 F5=32
(Gain, N.F., Compression, VSWR, Isolation)
IMPEDANCE: 50Ω INPUT 50Ω OUTPUT

1. INTERMODULATION DISTORTION

Input Level 0.25 VRMS IM Spec. -80 db

A. Standard Frequencies:

IM Product Freq.	2nd Order Level	3rd Order Level
2 MHz	-70	-52
14 MHz	-52	-50
30 MHz	-88	-84

B. Special Frequencies: N/A

F_1	F_2	F_3 Frequency	F_3 Level

2. NOISE FIGURE

N.F. Spec. 6.0 db

Frequency	Receiver N.F.(db) (F_b)	Combination N.F. (F_{ab})	Calculated Multicoupler N.F. (F_a)
F_1= 2 MHz	F_1 4.9	F_1 7.2	F_1 5.6 db
F_2= 6 MHz	F_2 4.9	F_2 6.9	F_2 5.4 db
F_3= 12 MHz	F_3 4.8	F_3 6.9	F_3 5.6 db
F_4= 18 MHz	F_4 4.9	F_4 6.9	F_4 5.5 db
F_5= 32 MHz	F_5 5.0	F_5 7.0	F_5 5.2 db

3. GAIN COMPRESSION N/A Compression Spec. _____ db @ _____ VRMS

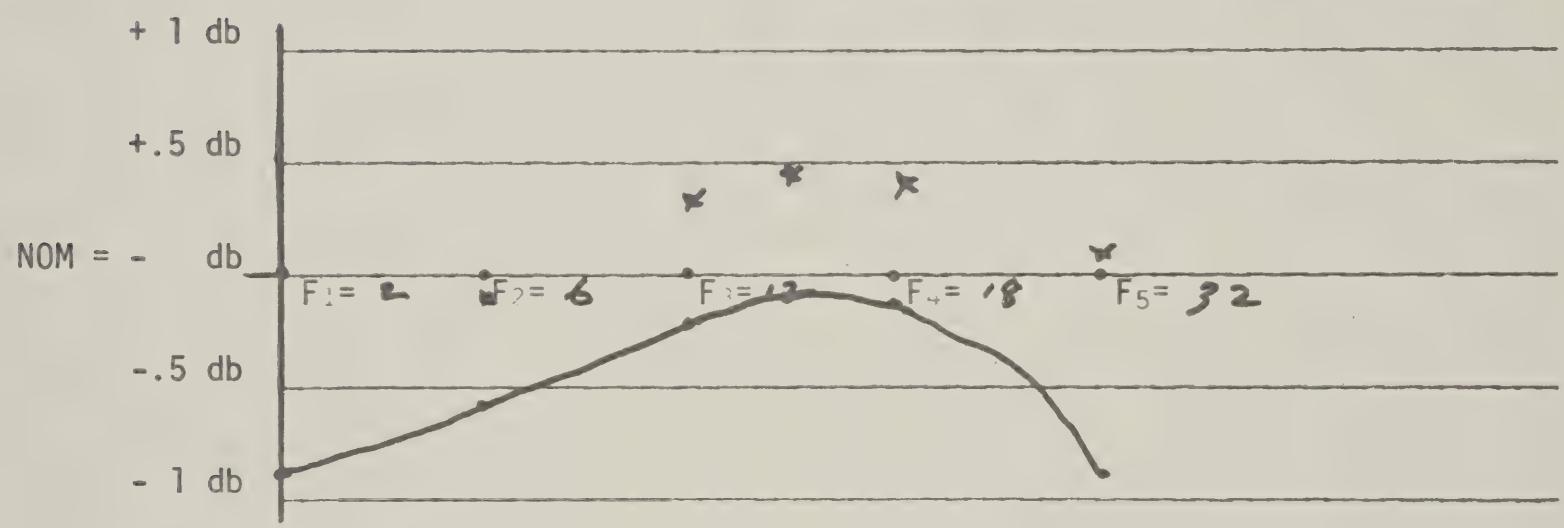
Test: Single Freq. ☐ Two Freq. ☐ Check One

Frequency	Input Level for Compression
F1= _____ MHz	F = _____
F2= _____ MHz	F2= _____
F3= _____ MHz	F3= _____
F4= _____ MHz	F4= _____
F5= _____ MHz	F5= _____

4. GAIN Gain Spec. 2 db ± 1.0 db

Gain Tracking _____ db ☐ Check if Gain Tracking is OK

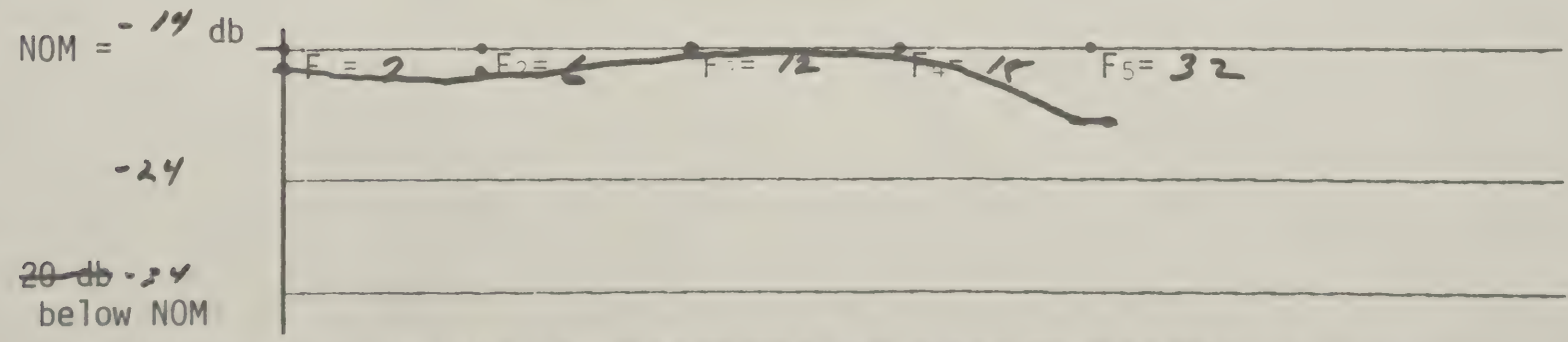
Frequency Range 2 MHz to 32 MHz



MEASURE GAIN AT FIVE (5) FREQUENCIES AND INDICATE FREQUENCY ON CHART

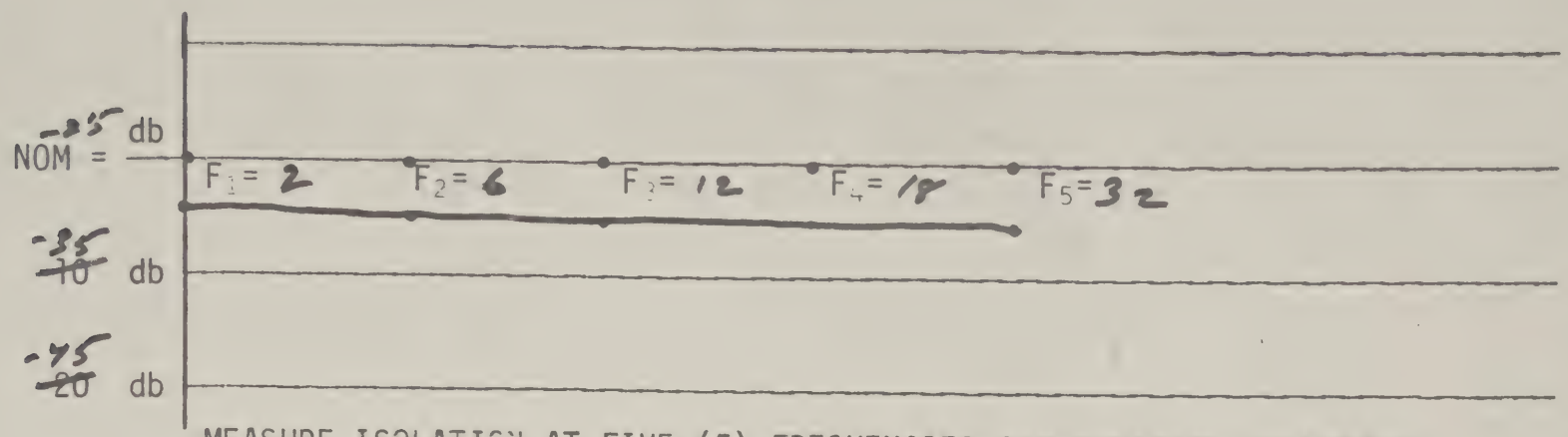
5. VSWR Specs: IMPEDANCE 50Ω INPUT VSWR 1.5:1 = -14 db

IMPEDANCE 50Ω OUTPUT VSWR 1.5:1 = -14 db



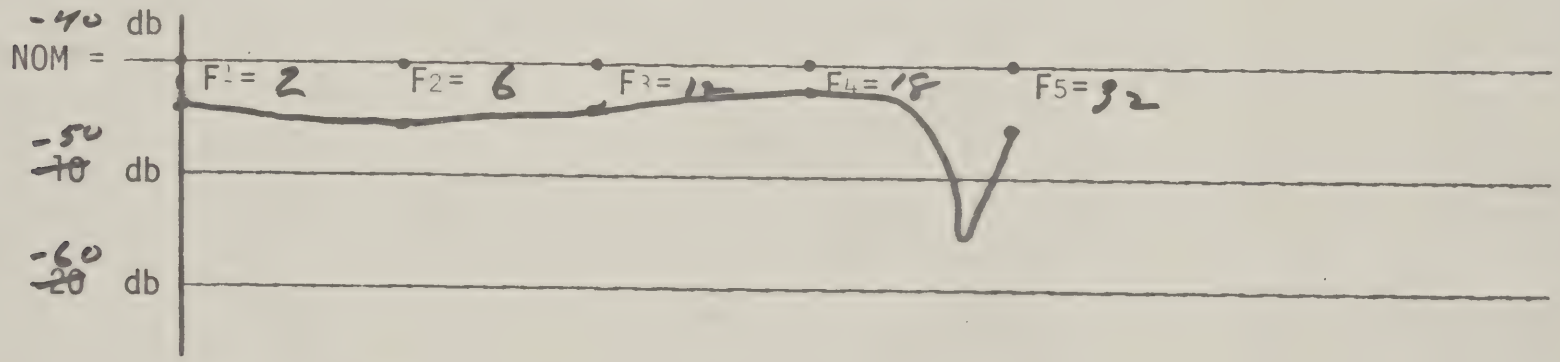
MEASURE VSWR AT FIVE (5) FREQUENCIES AND INDICATE FREQUENCY ON CHART.
INDICATE INPUT AND OUTPUT CURVE

6. REVERSE ISOLATION Spec. 35 db

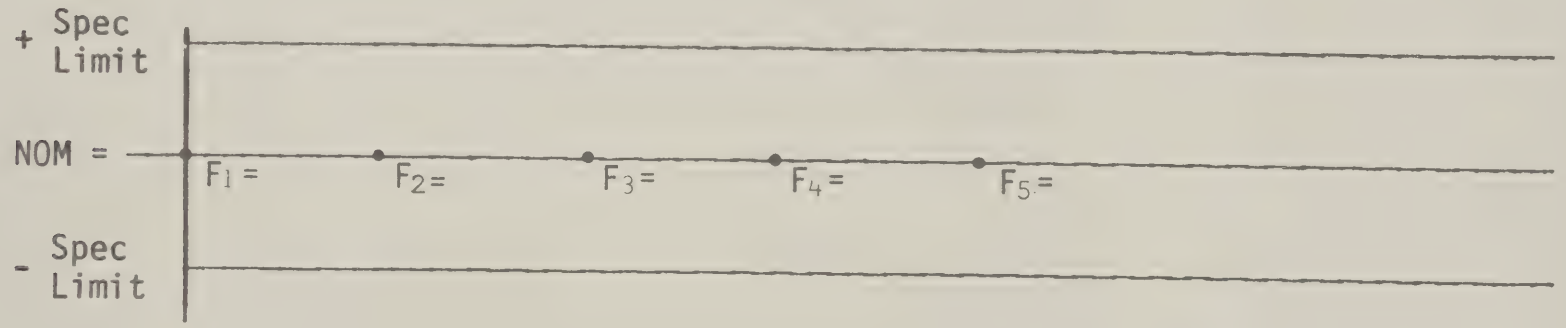


MEASURE ISOLATION AT FIVE (5) FREQUENCIES AND INDICATE FREQUENCY ON CHART

7. OUTPUT ISOLATION Spec. 40 db



8. PHASE TRACKING N/A Spec. _____ degrees



AIKEN ELECTRONICS

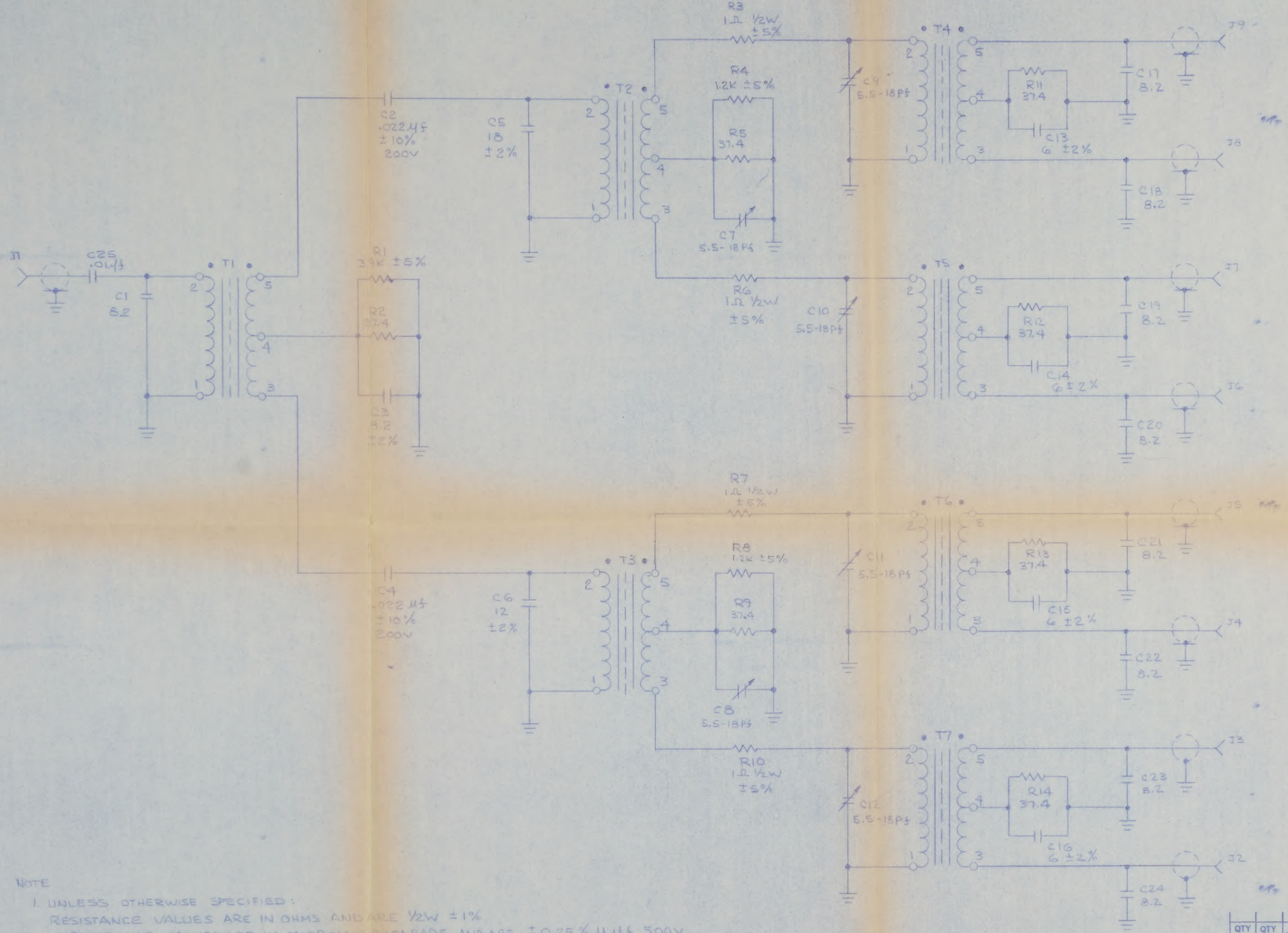
A Division of Aiken Industries, Inc.

5520 Port Royal Road

Springfield, Virginia 22151

AN AIKEN PRODUCT

REVISIONS				
SYM	ZONE	DESCRIPTION	DATE	APPD



NOTE

1. UNLESS OTHERWISE SPECIFIED:
   RESISTANCE VALUES ARE IN OHMS AND ARE ½W ±1%
   CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ARE ±0.25% μμf 500V

HIGHEST REF DESIGNATION
R14
C24
T7
J9

QTY REQD	QTY REQD	SYM	ITEM NO.	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MATERIAL	REF DESIG
—2	—1				LIST OF MATERIALS			

	MC1003	
	MC1002	
P/G	USED ON	NEXT ASSY
APPLICATION		

FINISH:

INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ON: FRACTIONS DECIMALS ANGLES ± ± ±

MATERIAL:

SIGNATURE	DATE
DR R SEELSI	11/10/65
DWG SUP	
CHK	
DES ENGR	
ENGR	
ENGR	
PROJ	
APPD	

AIKEN ELECT
SPRINGFIELD VA.

SCHEMATIC DIAGRAM
1/8 DIVIDER (75/75-2)
H.F. MULTICOUPLER

CODE IDENT NO.	SIZE	
		34-0013
SCALE		SHEET